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(54) **WEB TRANSPORTATION GUIDING APPARATUS AND METHOD**

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(30) **Foreign Application Priority Data**

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B65H 43/08 (2006.01)
B65H 20/00 (2006.01)

(52) **U.S. Cl.** **226/20**; 226/95; 226/97.3

(58) **Field of Classification Search** 226/95, 226/97.3, 15, 19, 20; 242/615.11
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,549,098 A * 12/1970 Koskela et al. 242/542.4
3,587,962 A * 6/1971 Leverkusen et al. 226/95
4,328,626 A * 5/1982 Leitner 34/115
4,453,659 A 6/1984 Torpey
4,888,848 A * 12/1989 Serracant-Clermont et al. 15/309.1
4,919,319 A * 4/1990 Ford et al. 242/615.12
4,958,111 A 9/1990 Gago
5,087,313 A * 2/1992 Duecker 156/271
5,104,489 A * 4/1992 Beisswanger et al. 162/369
5,114,062 A * 5/1992 Kuhn et al. 226/95
5,232,141 A * 8/1993 Mittmeyer et al. 226/95
5,358,163 A * 10/1994 Naka 226/95
5,489,784 A * 2/1996 Koiranen et al. 250/548
5,554,262 A * 9/1996 Turner 162/198
5,915,648 A * 6/1999 Madrzak et al. 242/615.2
6,004,432 A * 12/1999 Page et al. 162/281
6,038,976 A * 3/2000 Helmstadter et al. 101/410
6,124,201 A 9/2000 Wang et al.
6,250,581 B1 * 6/2001 Cramer 242/541.7
6,328,194 B1 * 12/2001 Meschenmoser 226/95
6,364,247 B1 * 4/2002 Polkinghorne 242/615.11
6,488,194 B1 * 12/2002 Couturier 226/95
6,705,220 B2 3/2004 Boucher
6,739,489 B1 * 5/2004 Nicolai et al. 226/95

(Continued)

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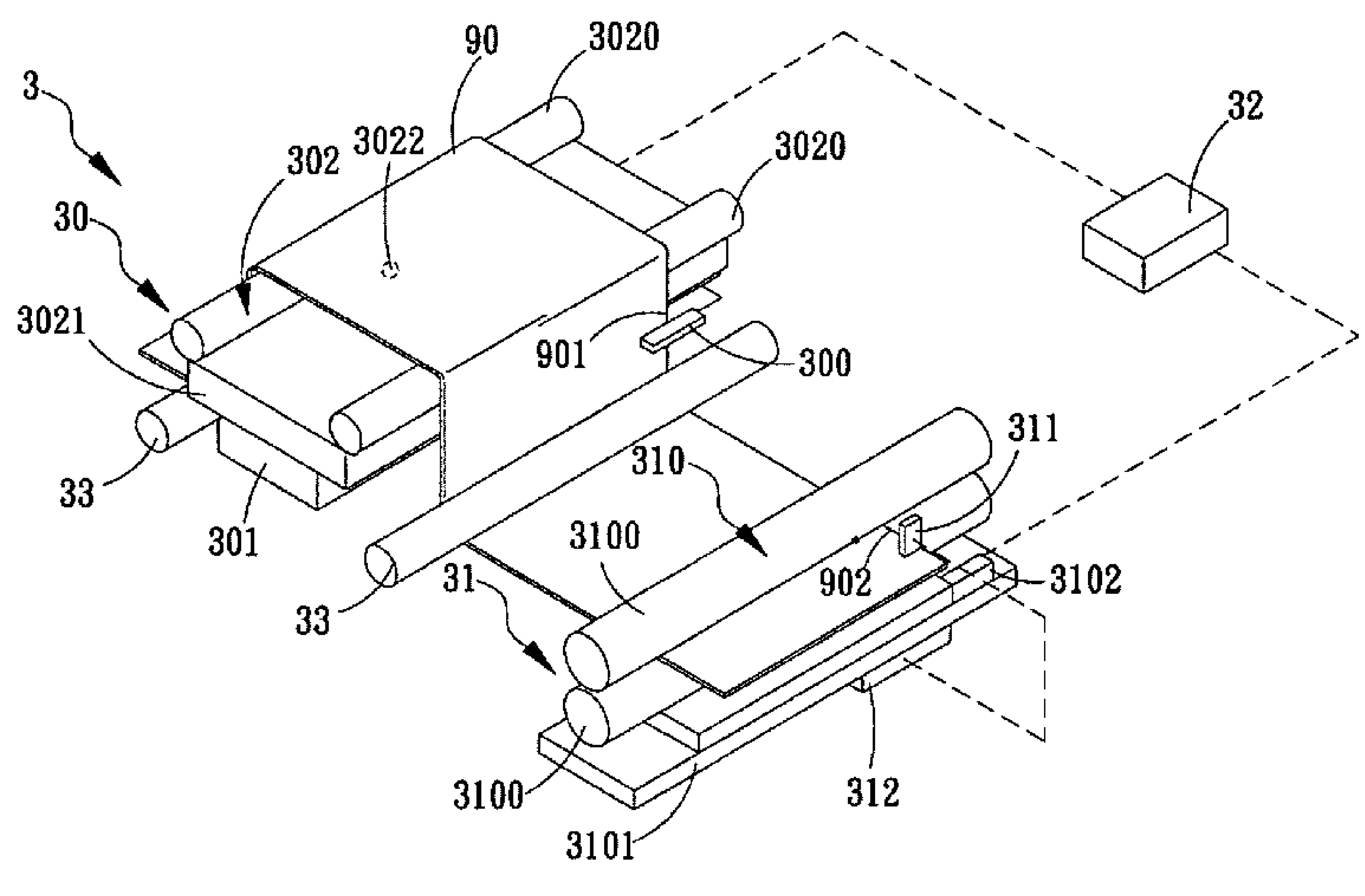
(57) **ABSTRACT**

A guiding apparatus and method for a shift generated by a web during web transportation is provided, in which a coarse position guiding module and a fine position guiding module function to directly adjust the web so as to compensate the shift occurred during the process of transportation according to a position of the web. By means of monitoring a location of the fine position guiding module at any time, a reference of the coarse position guiding module will be adjusted when the location of the fine position guiding module satisfies the condition defined in the guiding method, so as to change a position where the web enters into the fine position guiding module.

25 Claims, 16 Drawing Sheets



U.S. PATENT DOCUMENTS

6,786,449	B2 *	9/2004	Marcle-Geler et al.	242/615.12
7,025,303	B2 *	4/2006	Meyer	242/615.12
7,267,255	B1	9/2007	Young et al.	
7,311,234	B2 *	12/2007	Solberg	226/97.3
7,383,772	B2 *	6/2008	Boppel et al.	101/228
2002/0113164	A1 *	8/2002	Marcle-Geler et al.	242/615.12
2006/0097101	A1 *	5/2006	Boppel et al.	242/615.12
2006/0261120	A1 *	11/2006	Slyne	226/95
2007/0102563	A1 *	5/2007	Kubota et al.	242/548
2008/0176728	A1 *	7/2008	Scheu	492/8

* cited by examiner

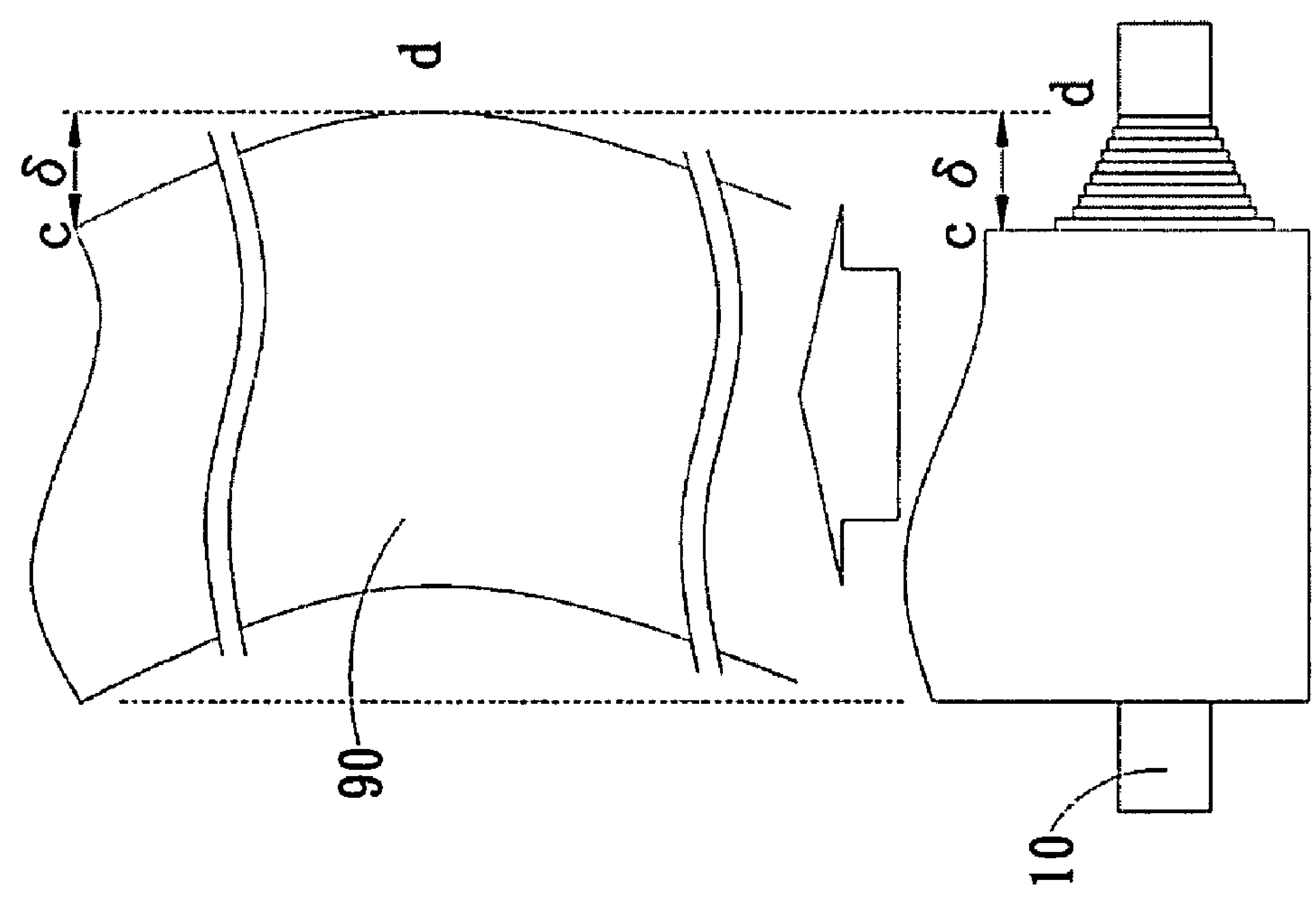


FIG. 1 PRIOR ART

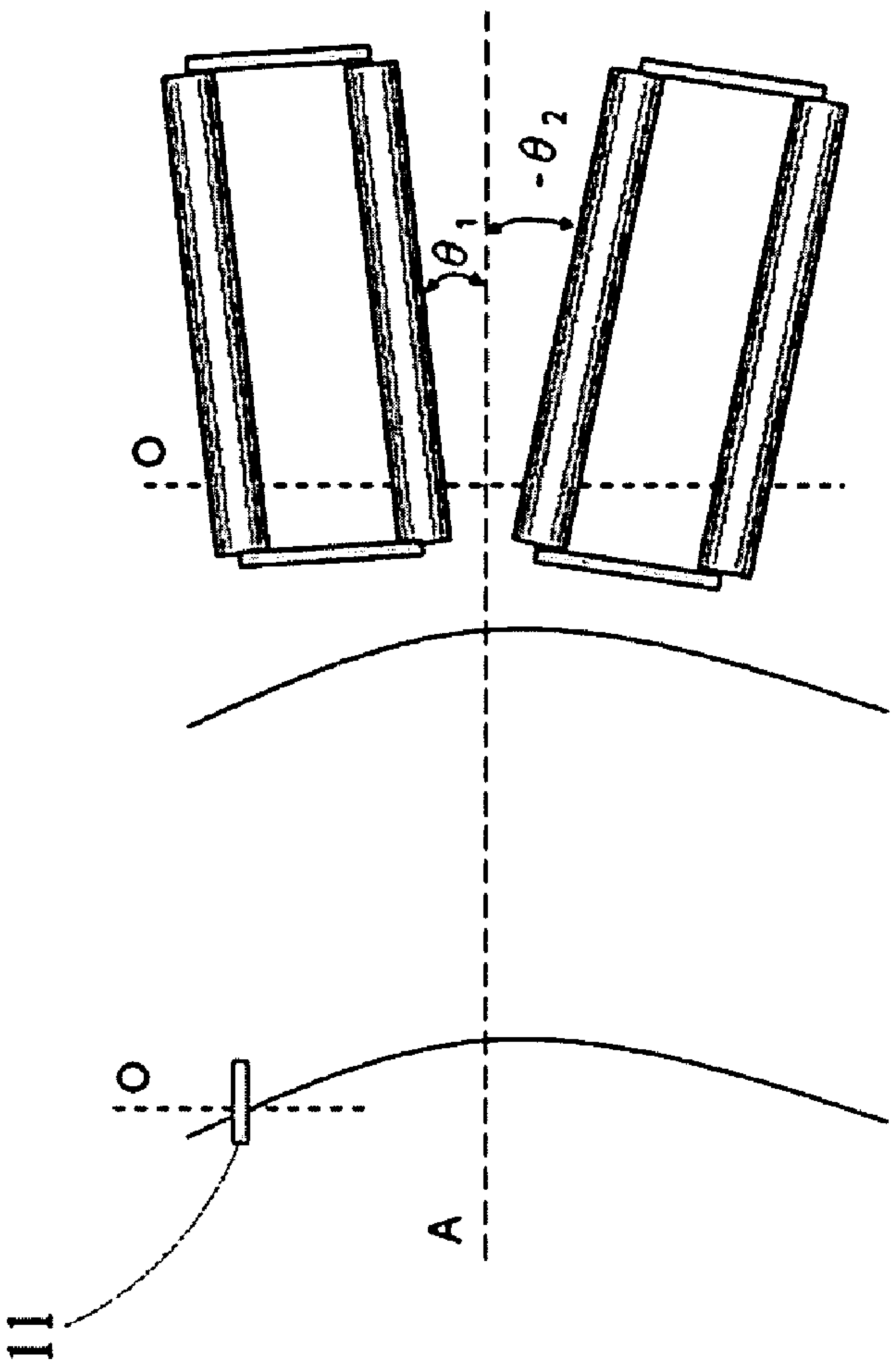


FIG. 2 PRIOR ART

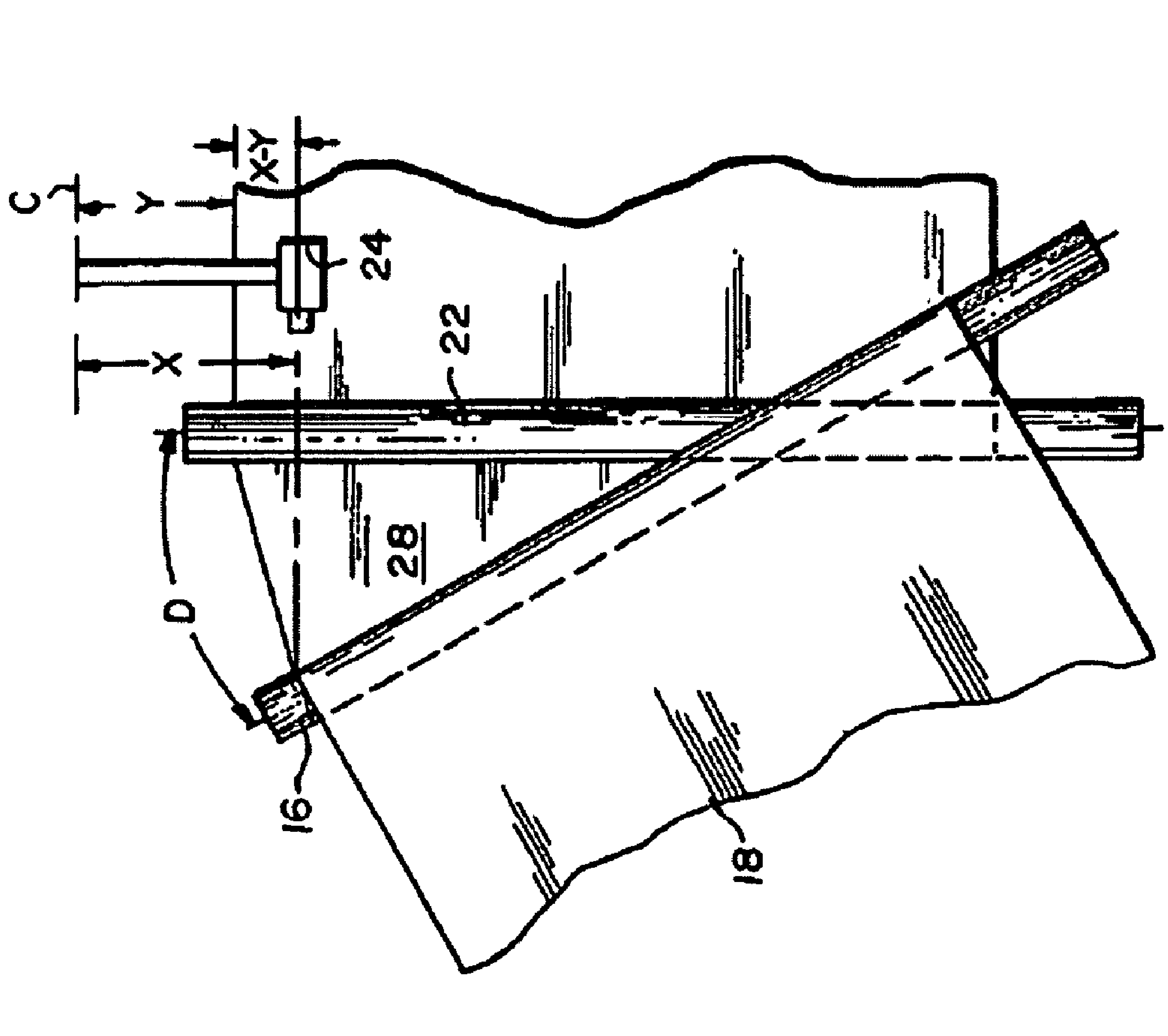


FIG. 3 PRIOR ART

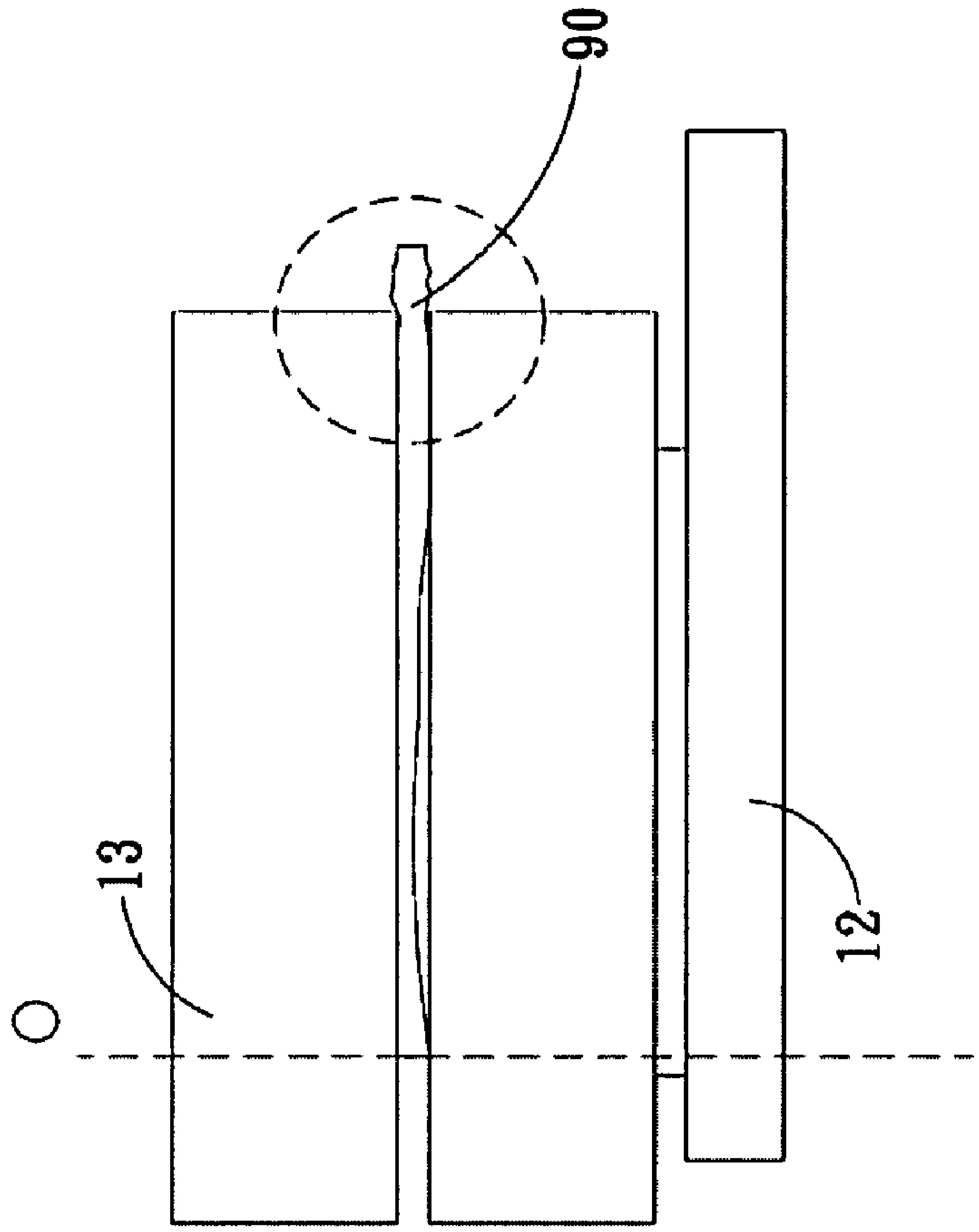


FIG. 4B

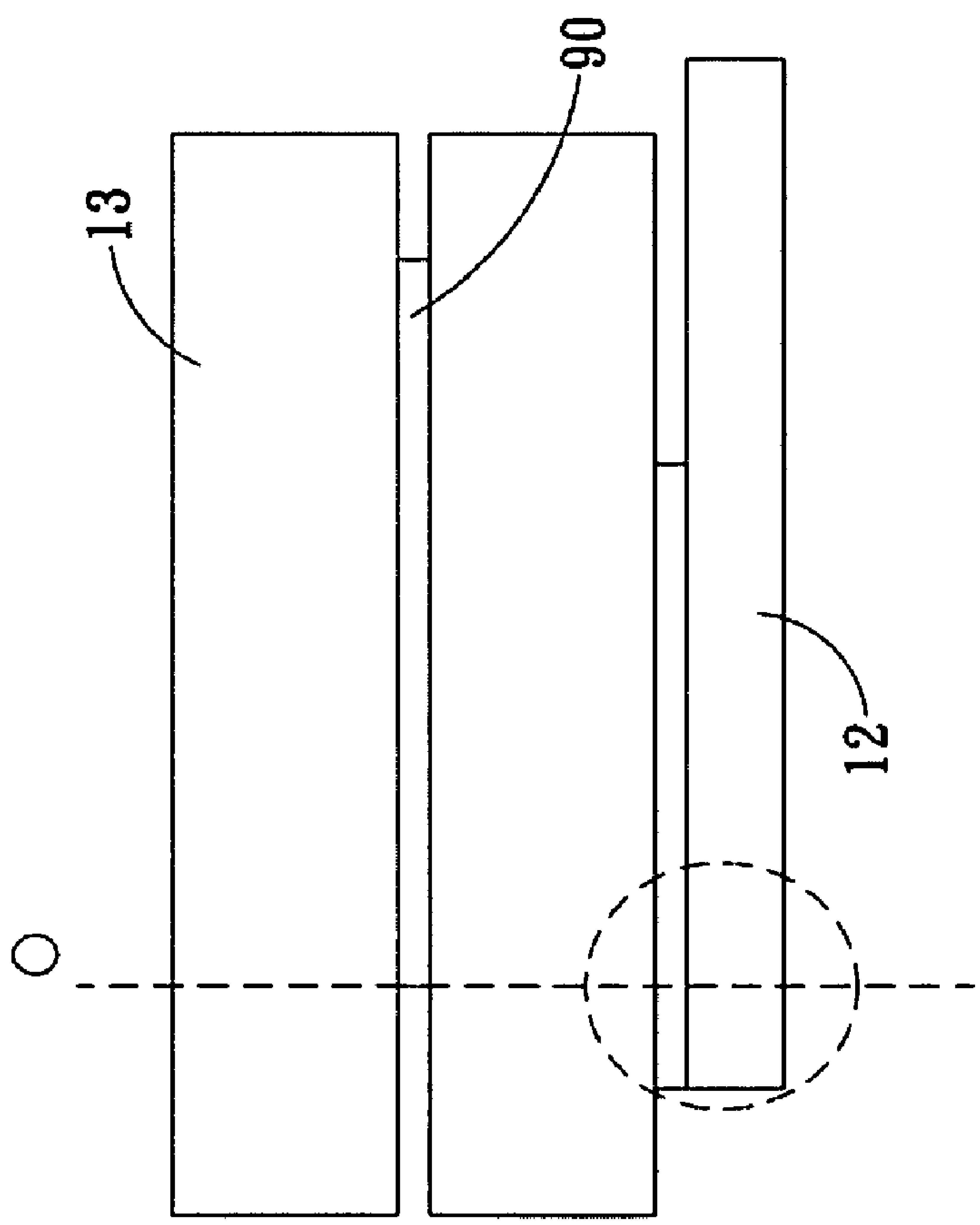


FIG. 4A

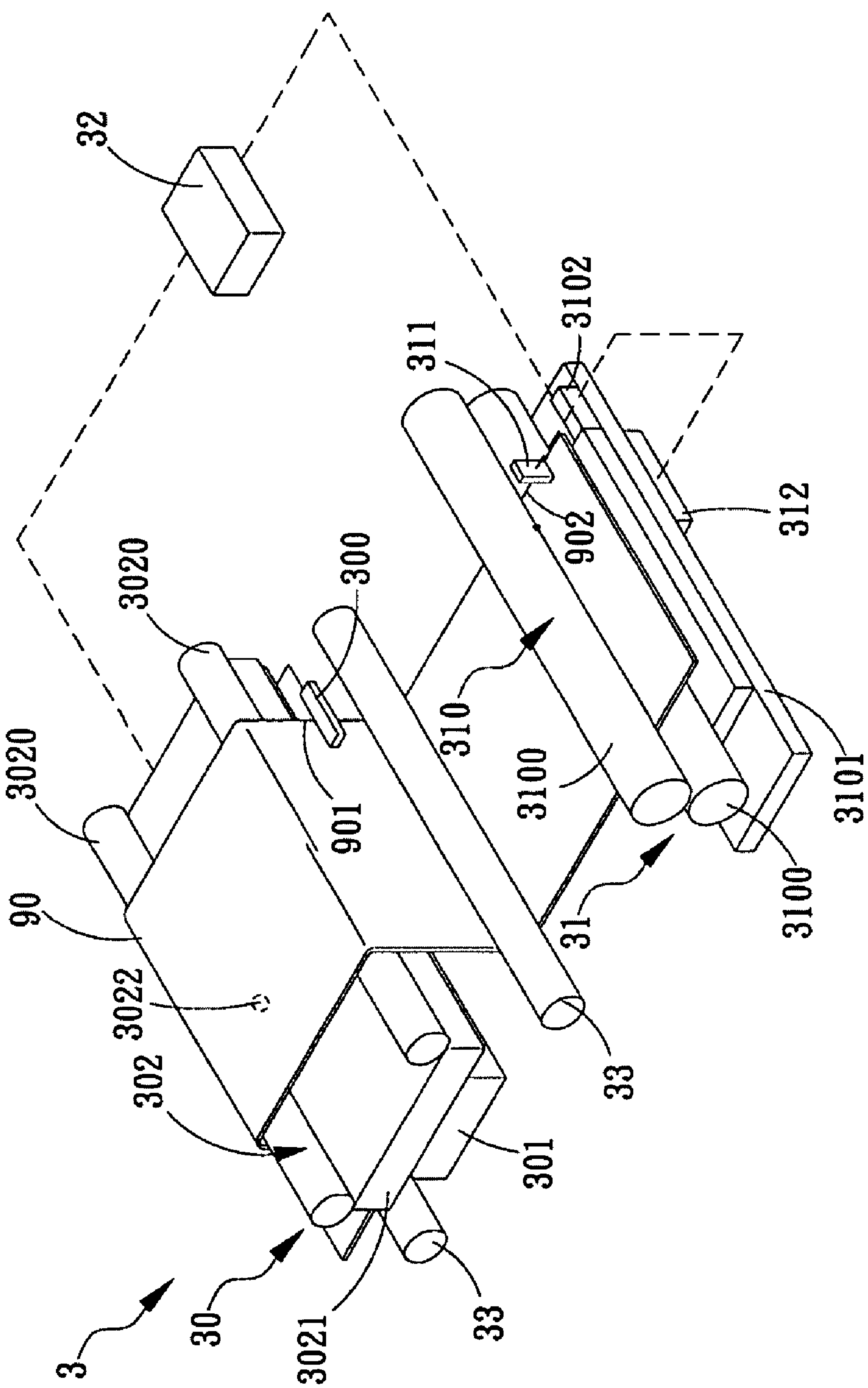

32
3102
311
312
902
3020
300
310
3100
3101
3020
901
3100
90
31
3022
302
33
301
3
30
3021
33

FIG. 5

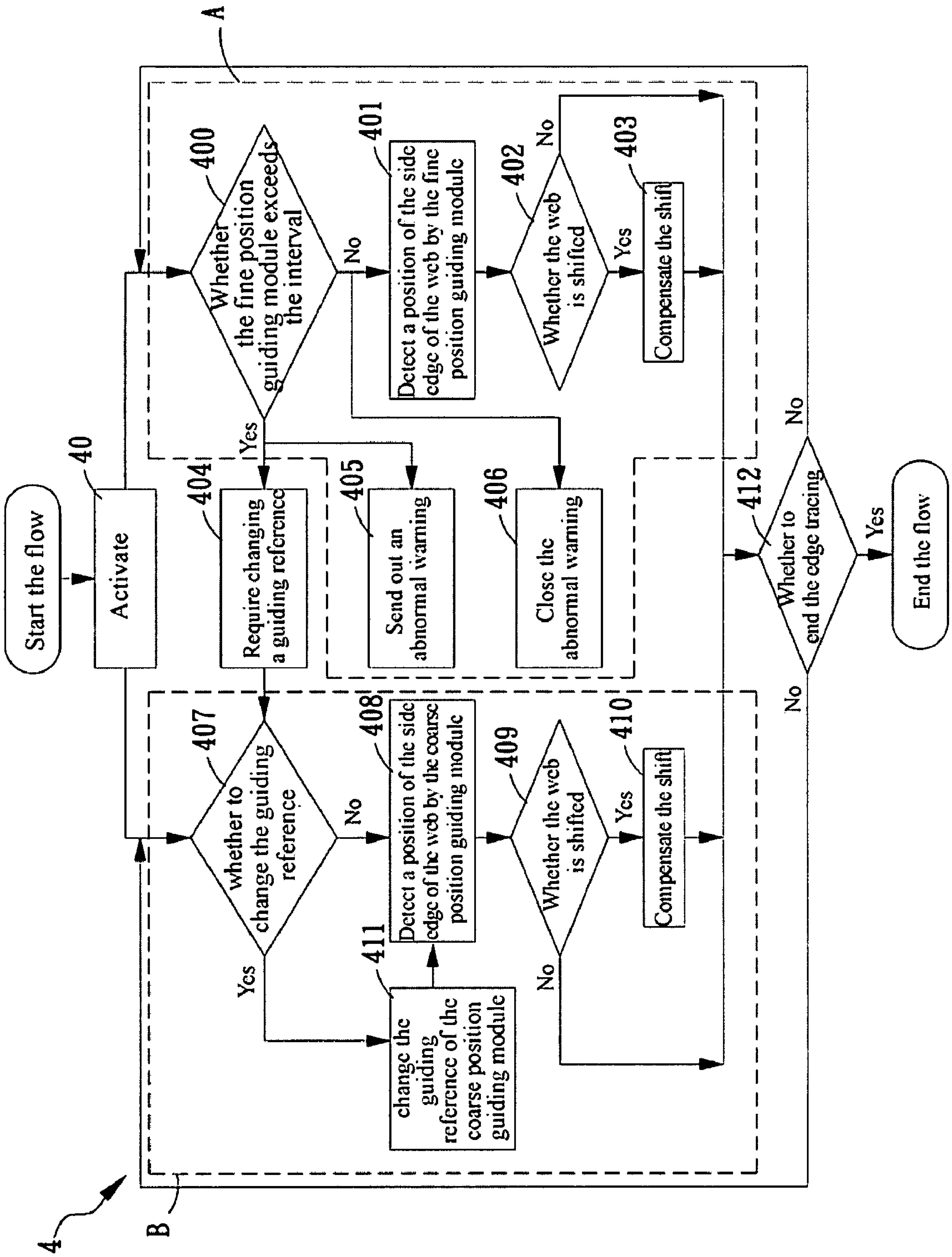

Start the flow
40
Activate
A
400
Whether the fine position guiding module exceeds the interval
Yes
No
401
Detect a position of the side edge of the web by the fine position guiding module
402
Whether the web is shifted
Yes
No
403
Compensate the shift
404
Require changing a guiding reference
405
Send out an abnormal warning
406
Close the abnormal warning
B
407
whether to change the guiding reference
Yes
No
408
Detect a position of the side edge of the web by the coarse position guiding module
409
Whether the web is shifted
Yes
No
410
Compensate the shift
411
change the guiding reference of the coarse position guiding module
412
Whether to end the edge tracing
Yes
No
No
End the flow
4

FIG. 6

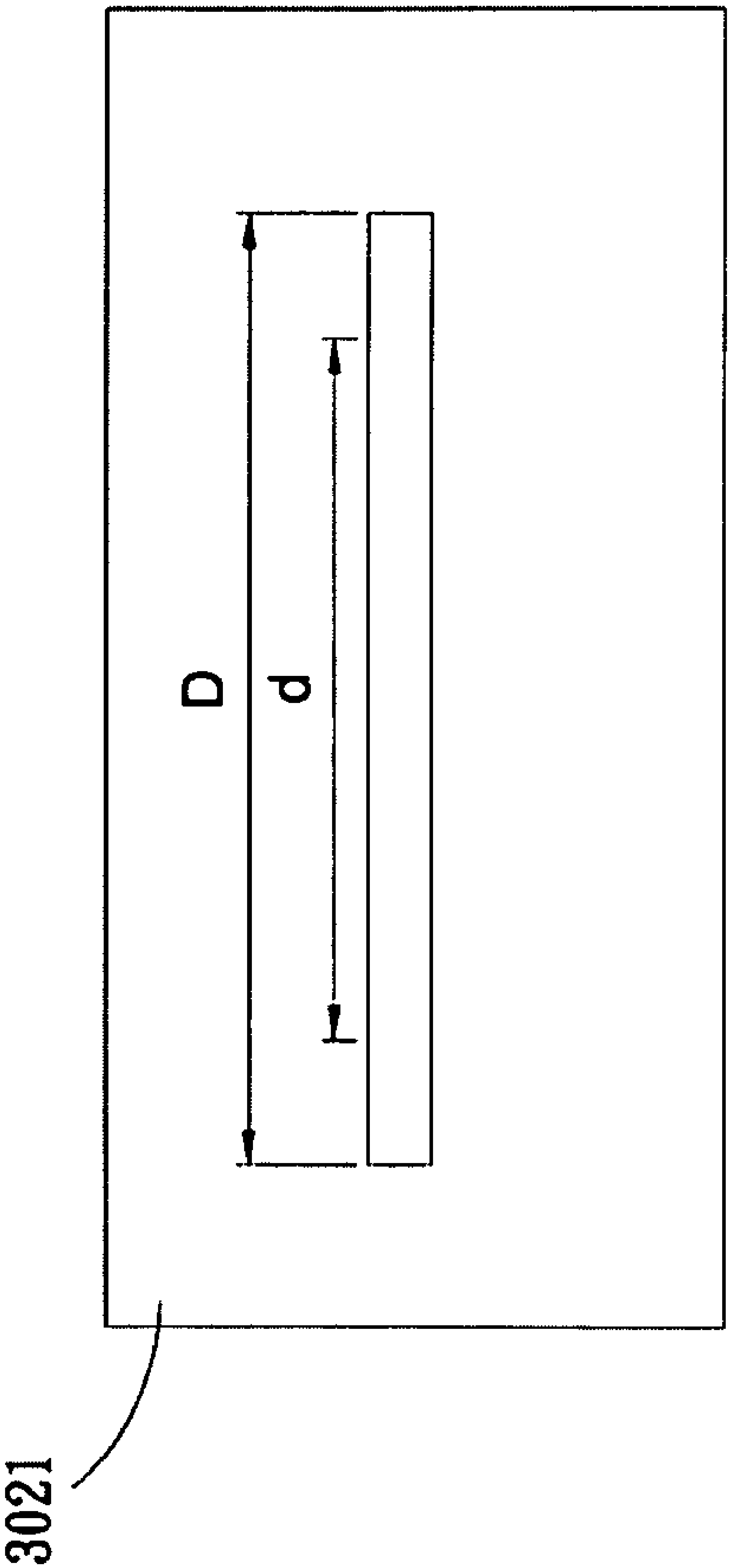


FIG. 7

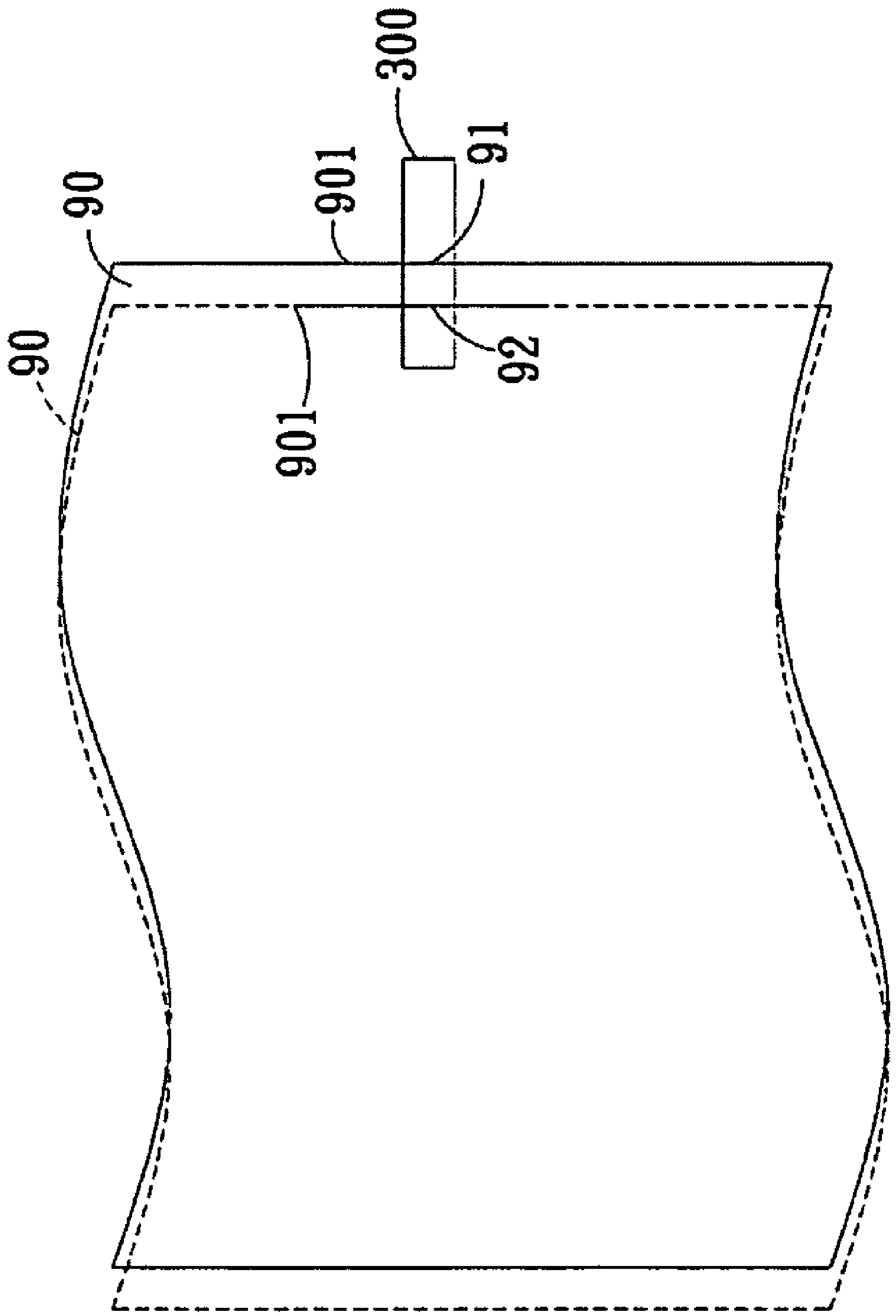


FIG. 8

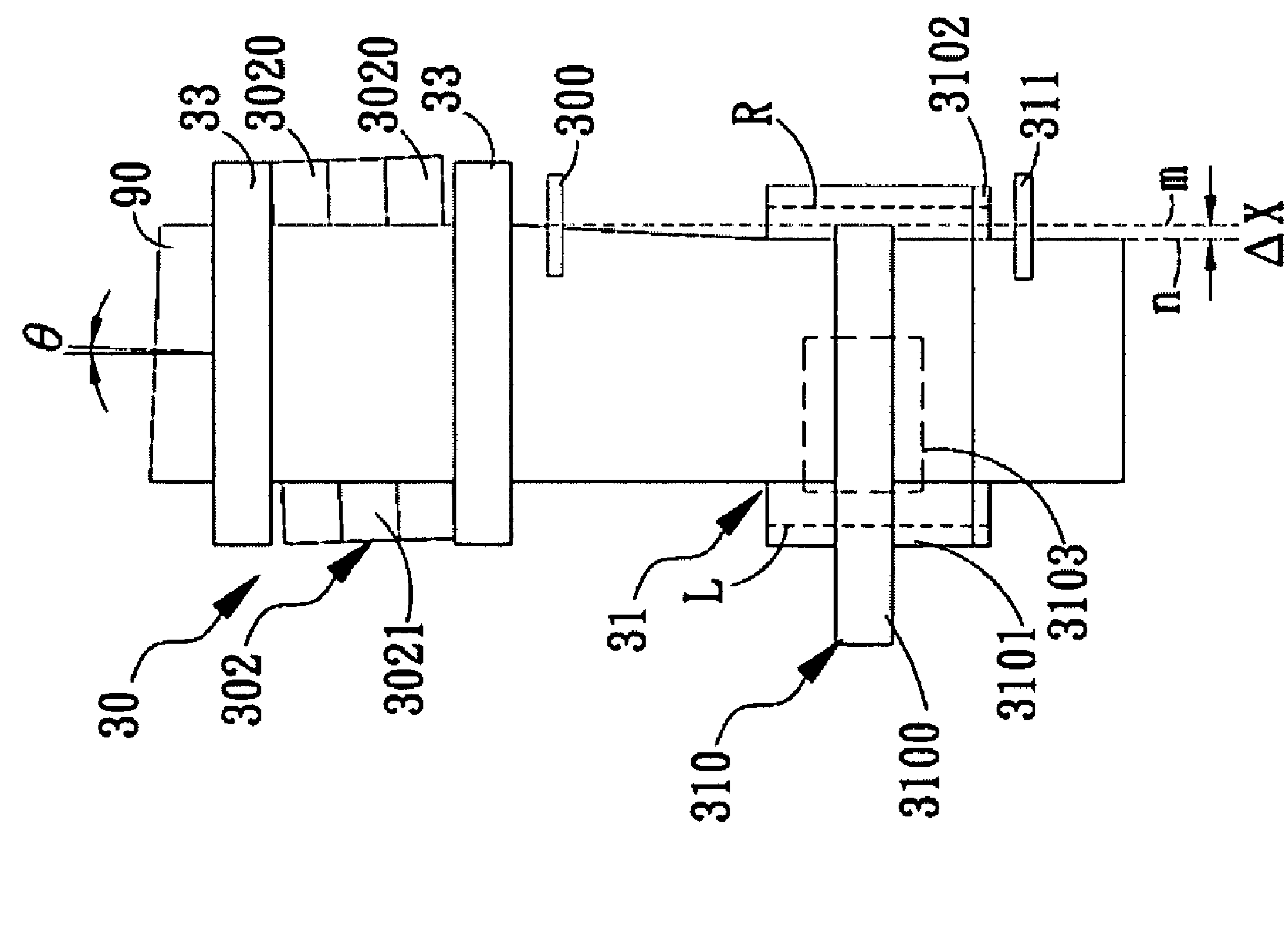

θ
90
33
3020
3020
33
300
R
3102
311
m
n
ΔX
30
302
3021
31
L
310
3100
3101
3103

FIG. 9A

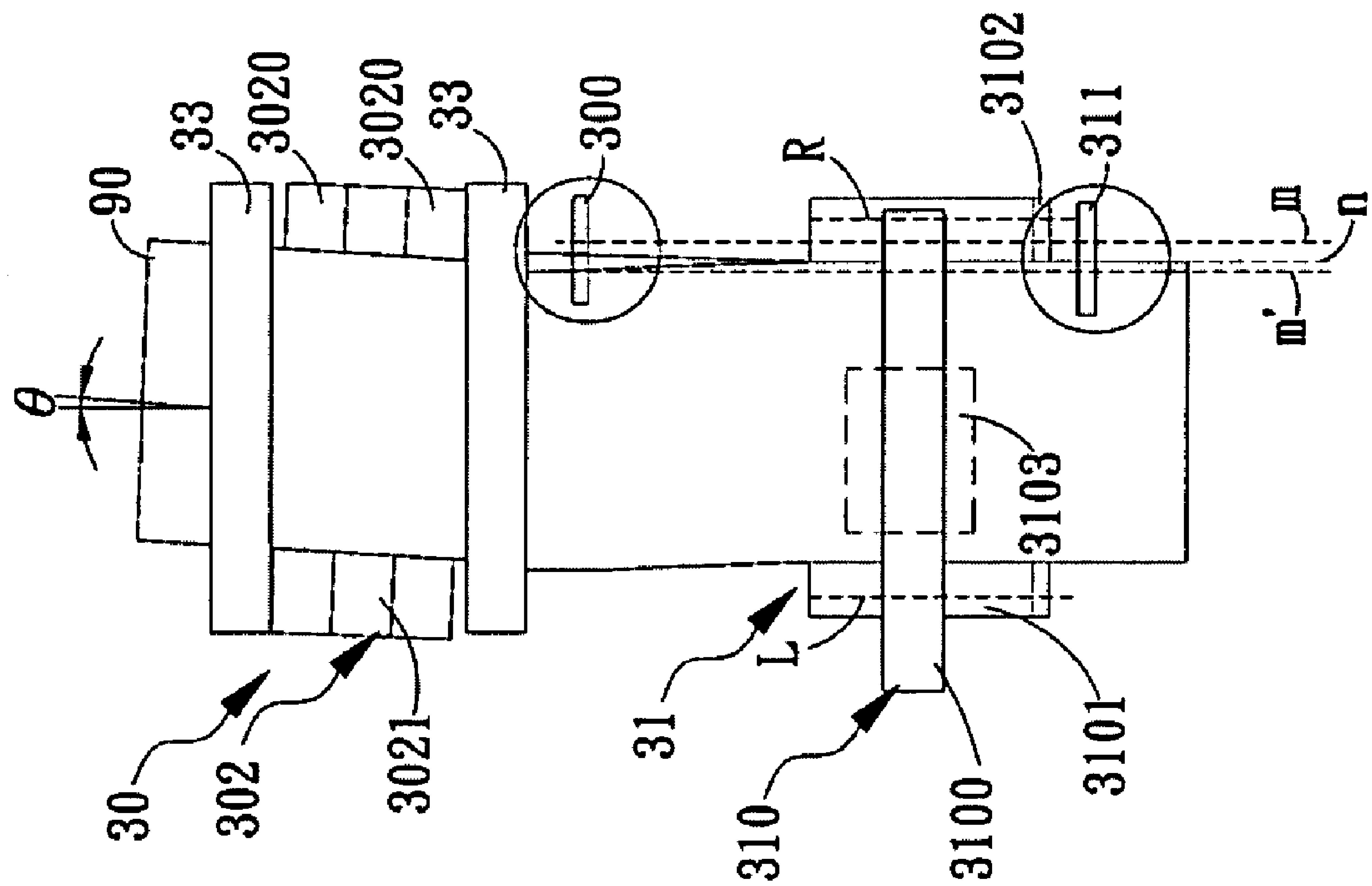

θ
90
33
3020
3020
33
300
R
3102
311
m
n
m'
3103
30
302
3021
31
L
310
3100
3101

FIG. 9B

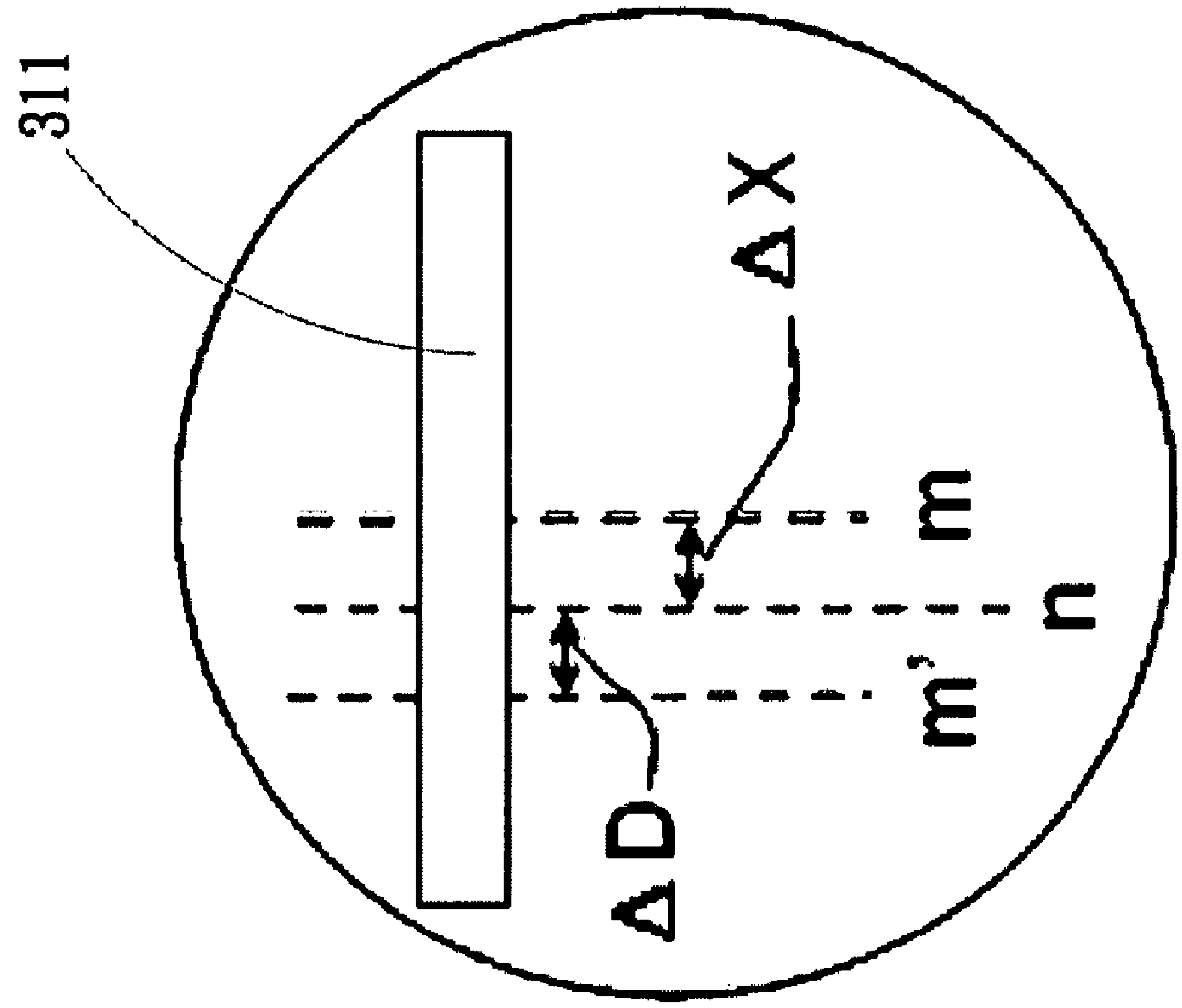


FIG. 10B

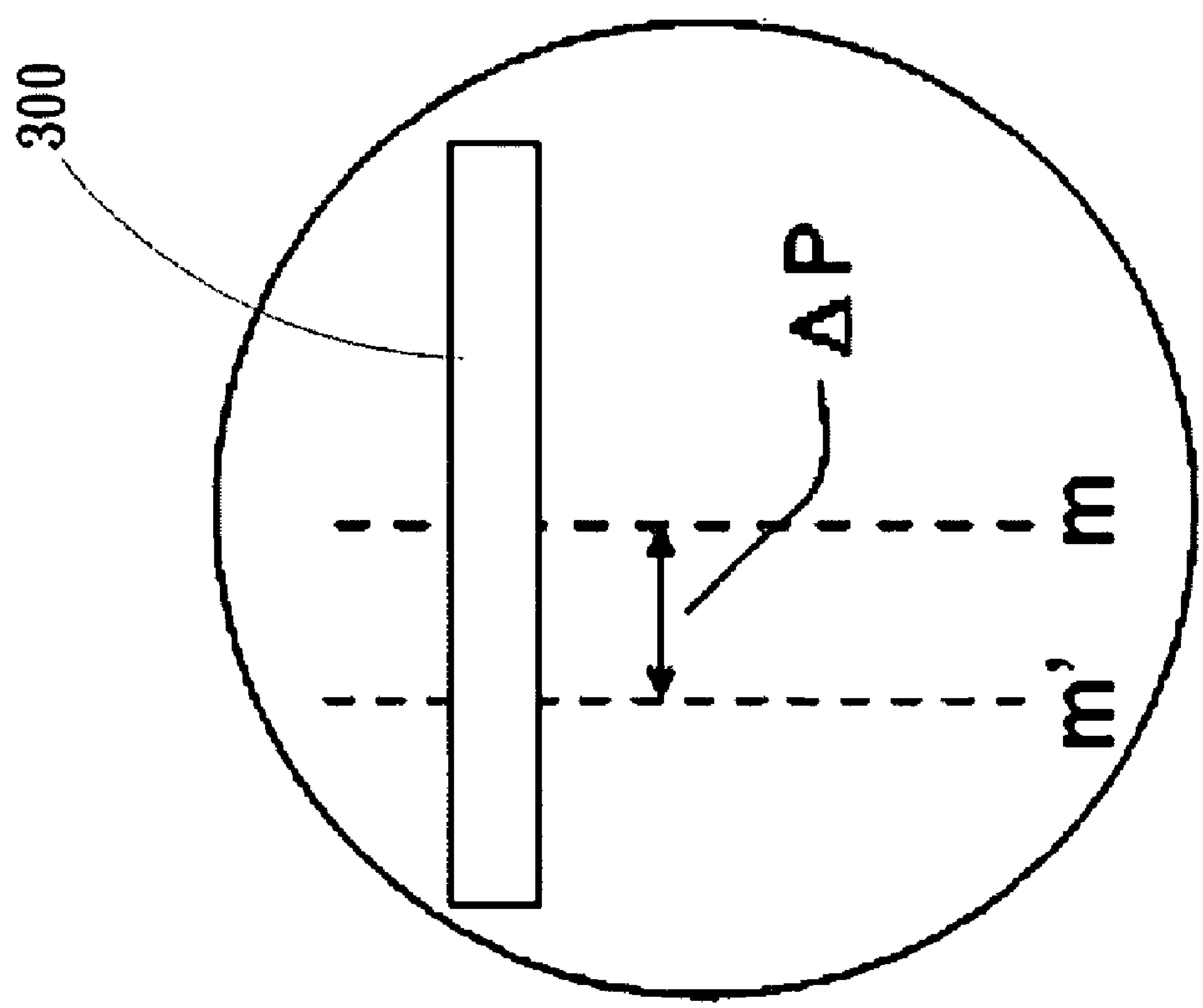


FIG. 10A

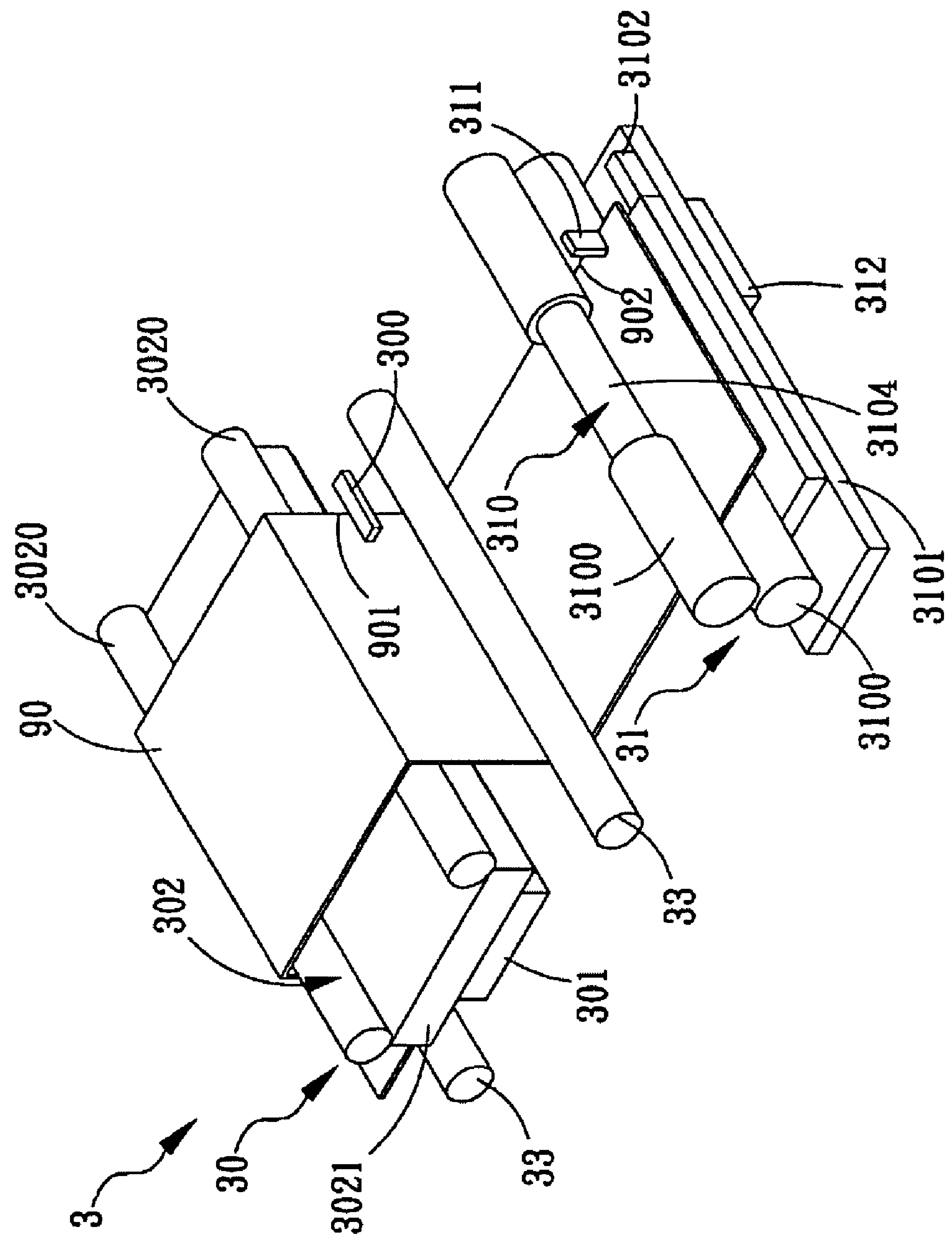

3
30
3021
33
302
301
90
3020
3020
901
300
33
31
3100
310
3100
3104
902
311
3102
312
3101

FIG. 11

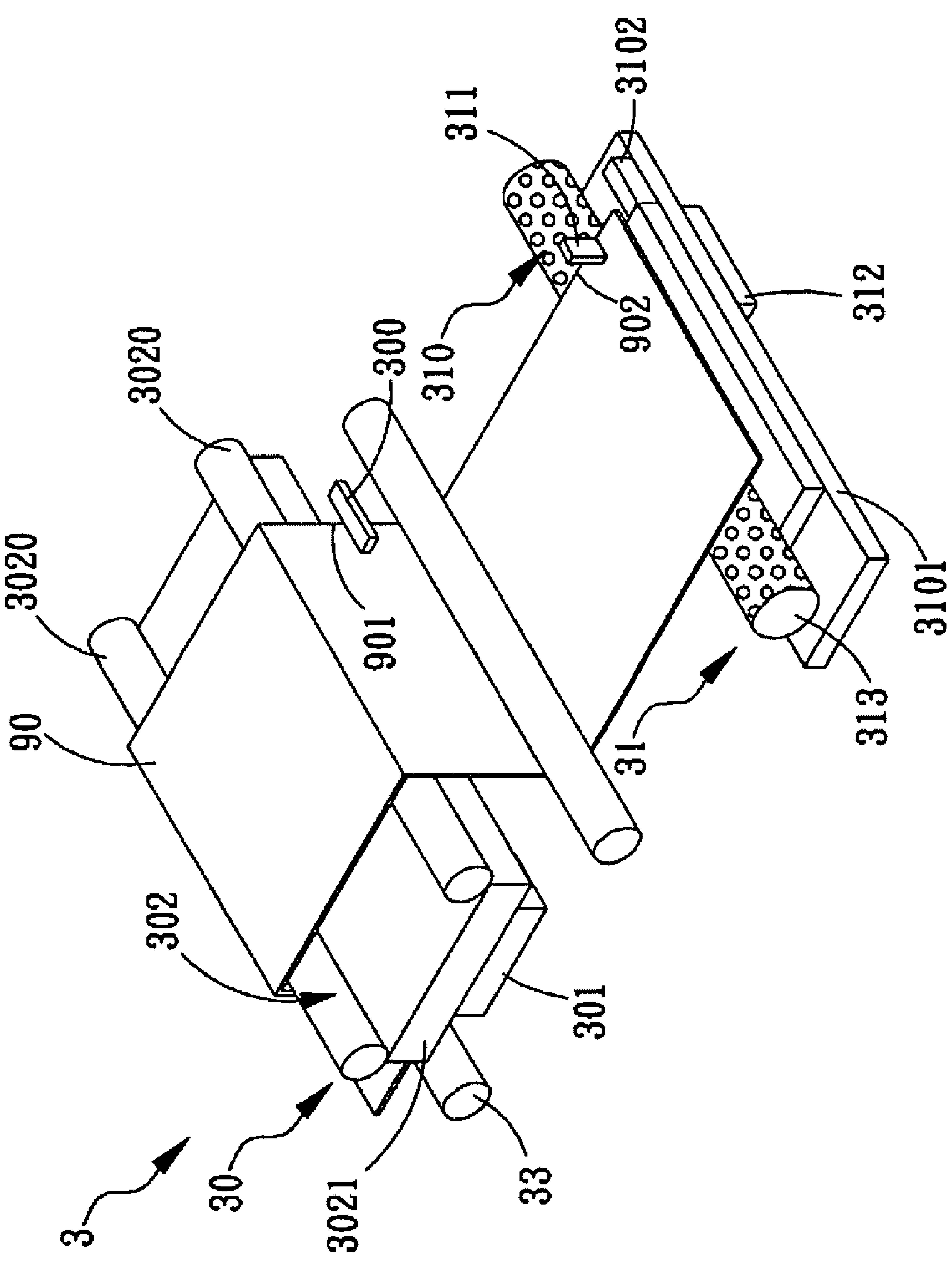

3
30
3021
33
302
301
90
3020
3020
901
300
310
311
902
3102
312
31
313
3101

FIG. 12A

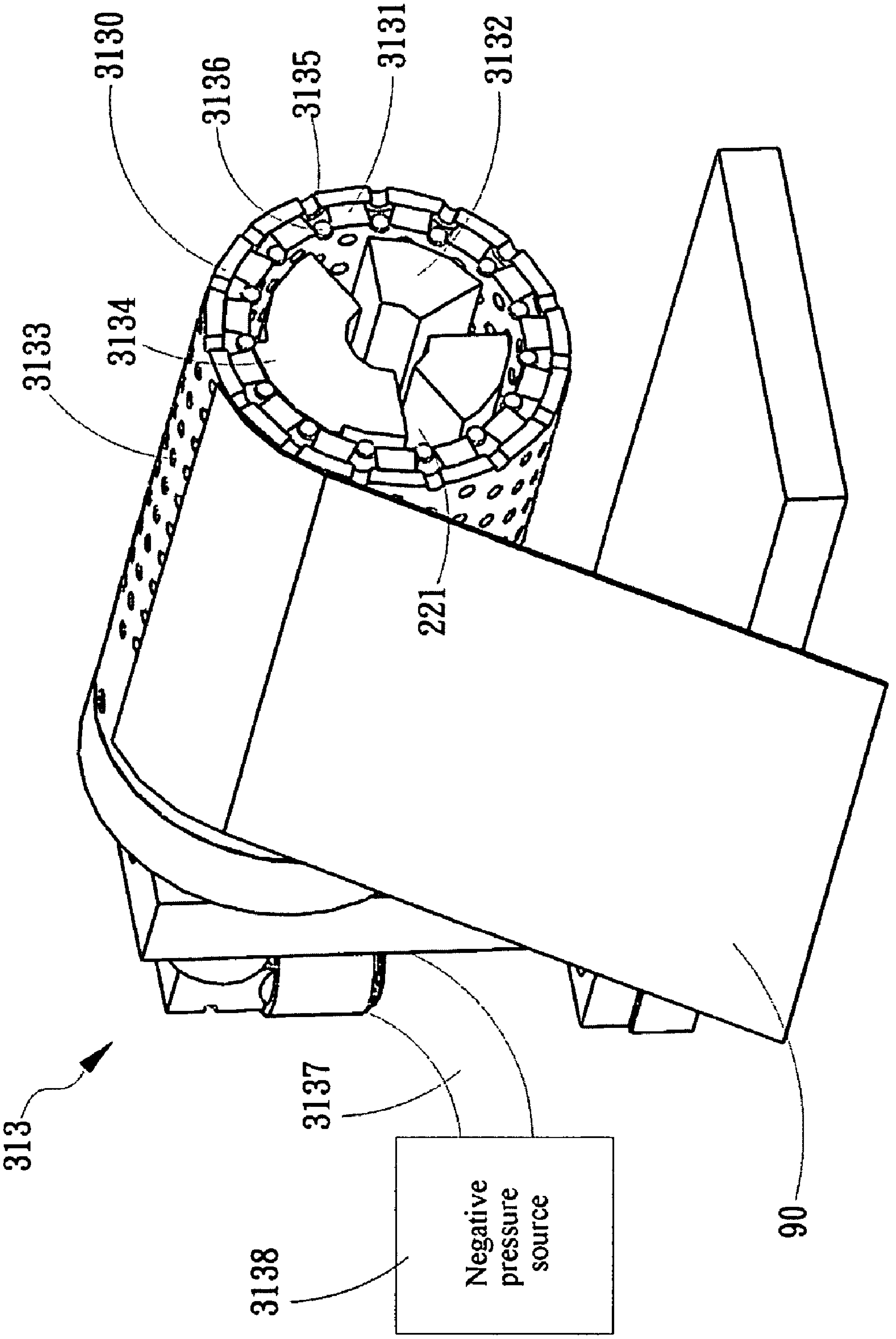

3130
3136
3135
3131
3132
3133
3134
221
313
3137
90
3138
Negative pressure source

FIG. 12B

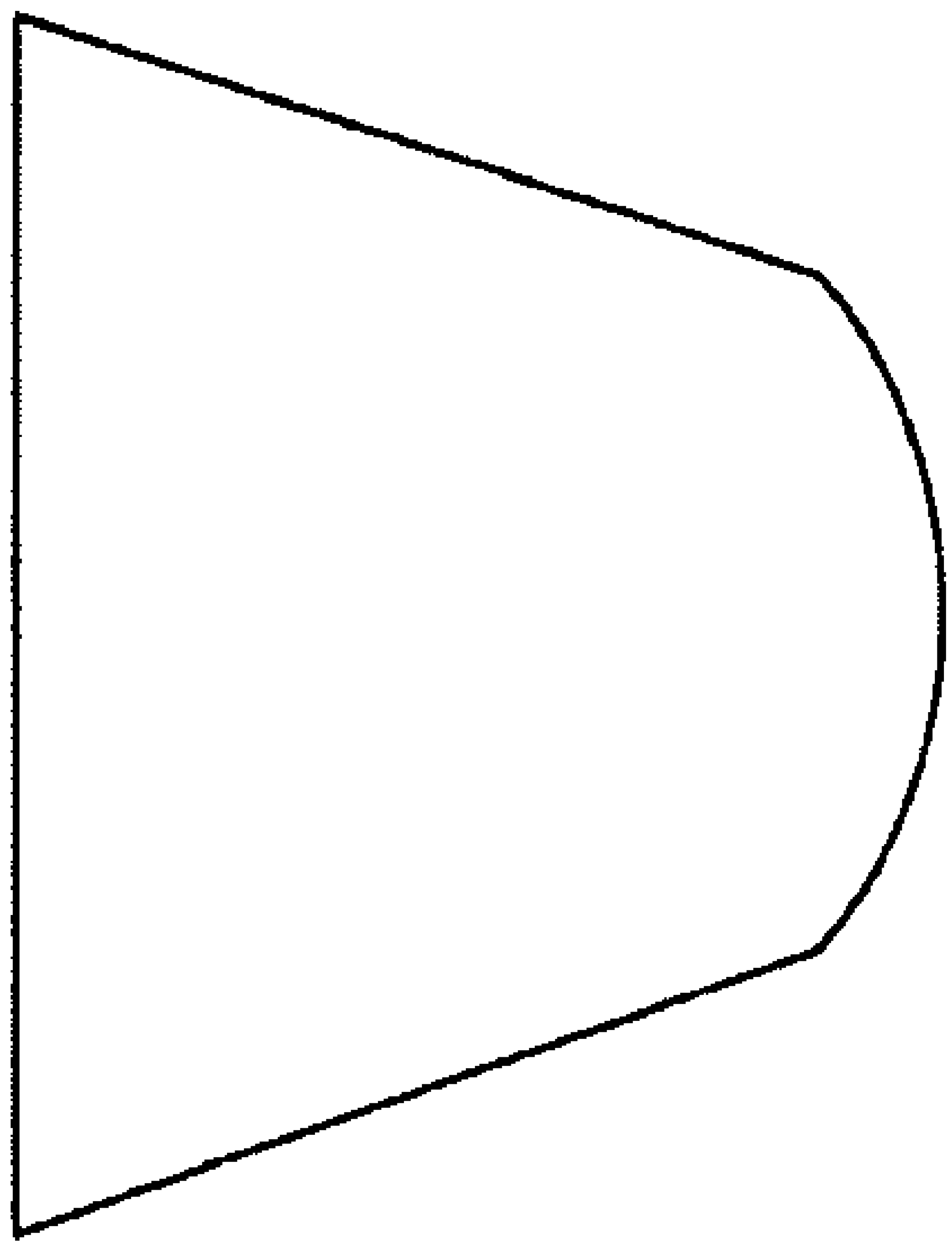


FIG. 13B

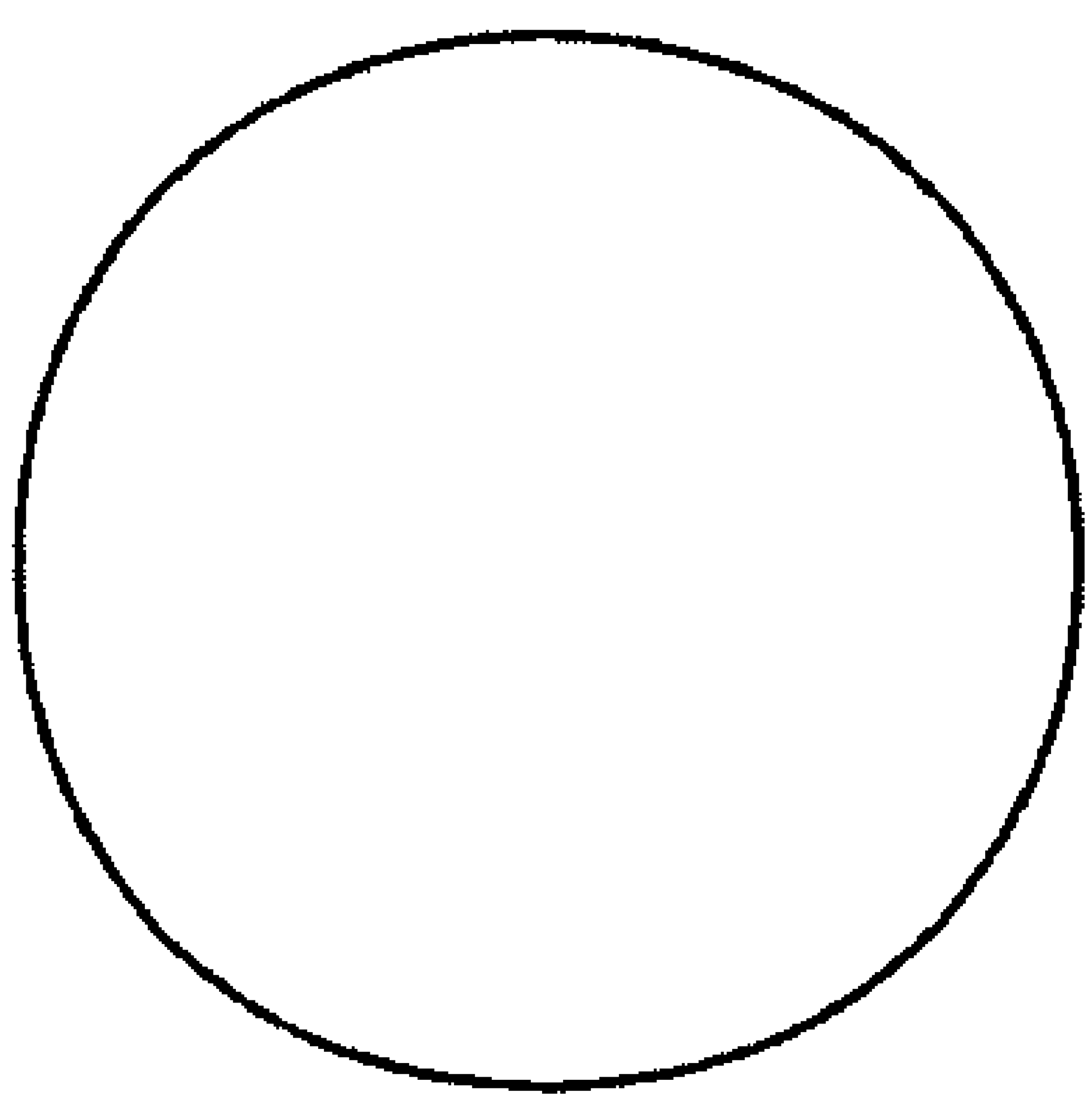


FIG. 13A

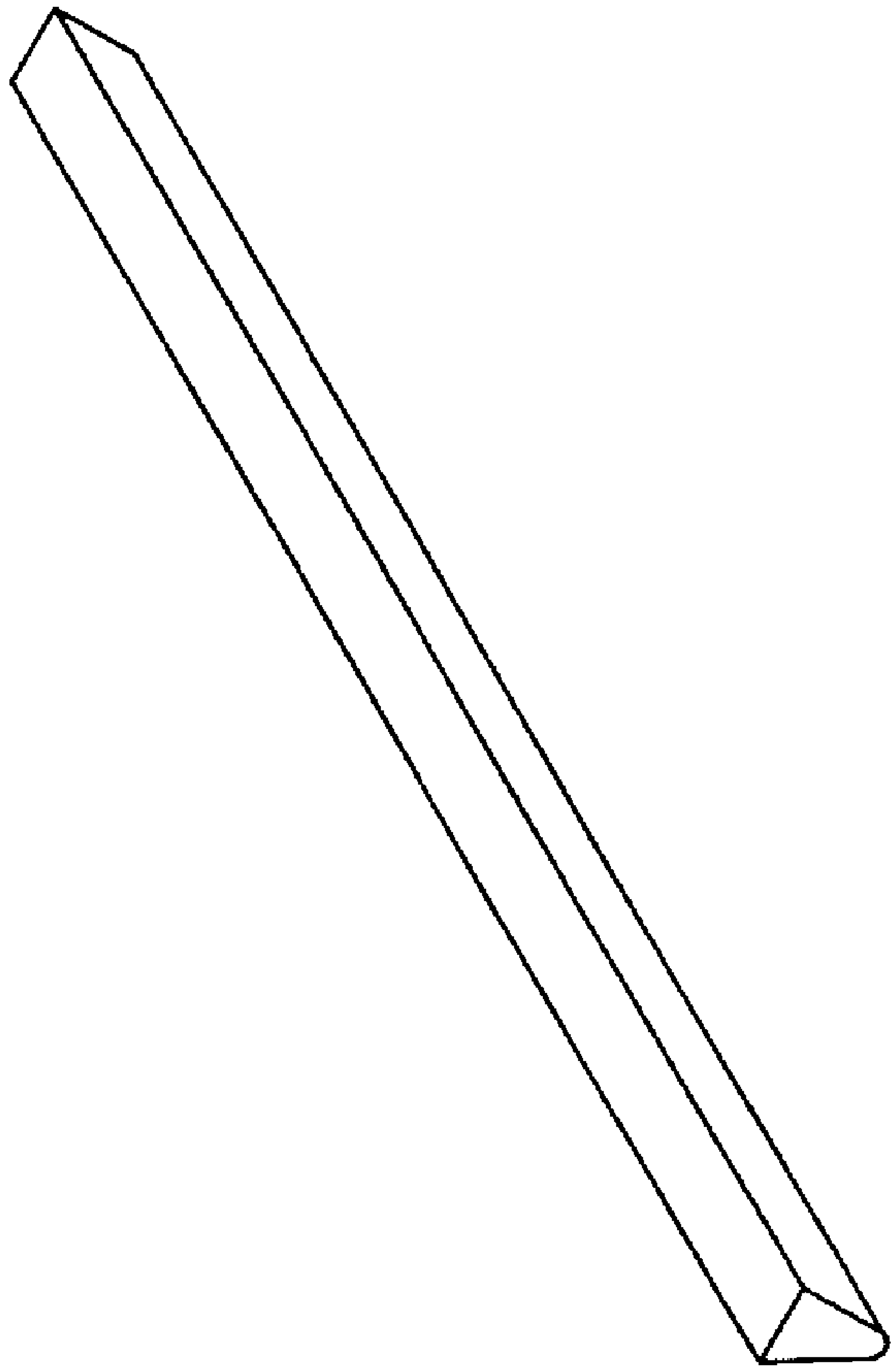


FIG. 13D

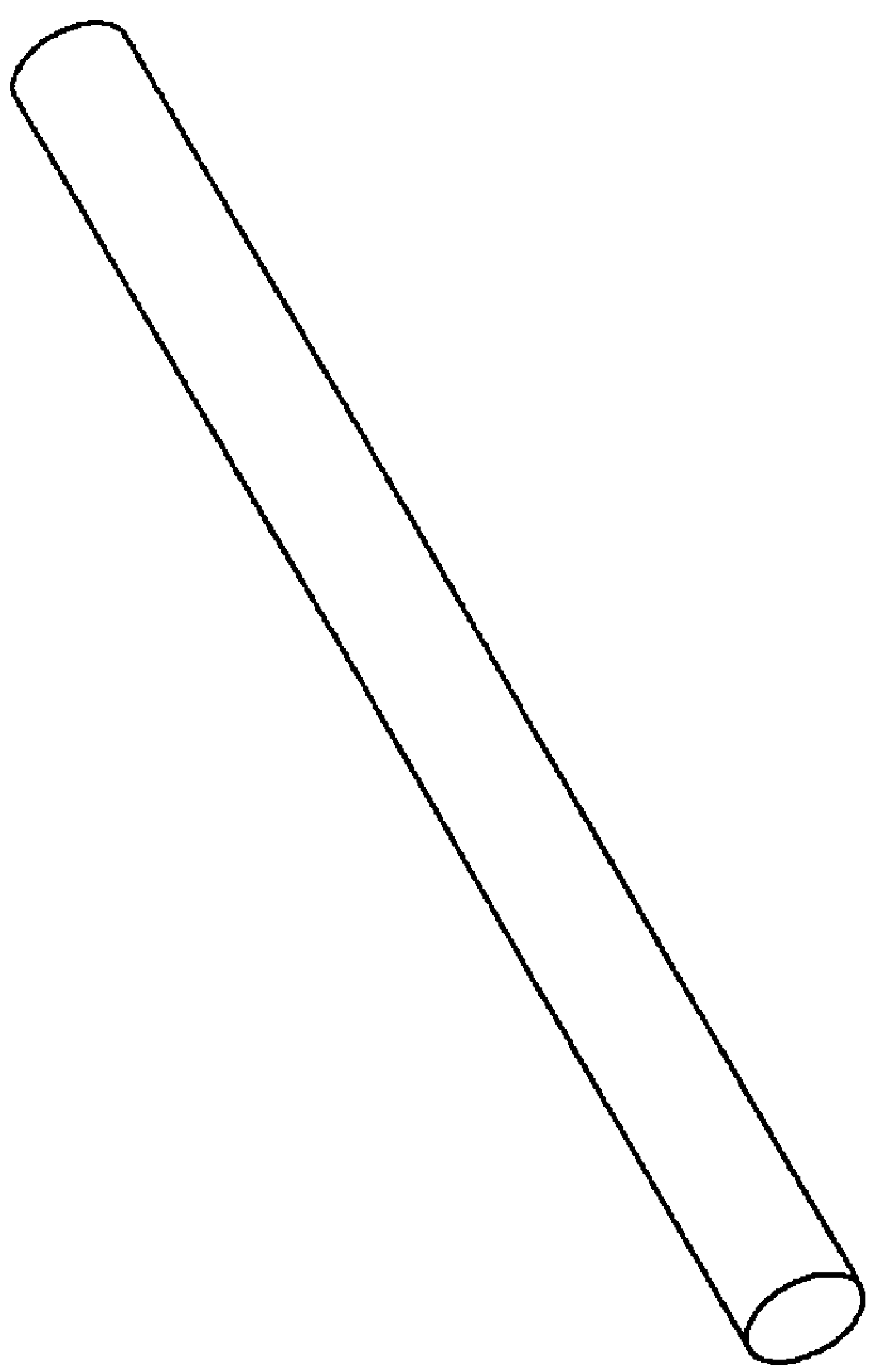


FIG. 13C

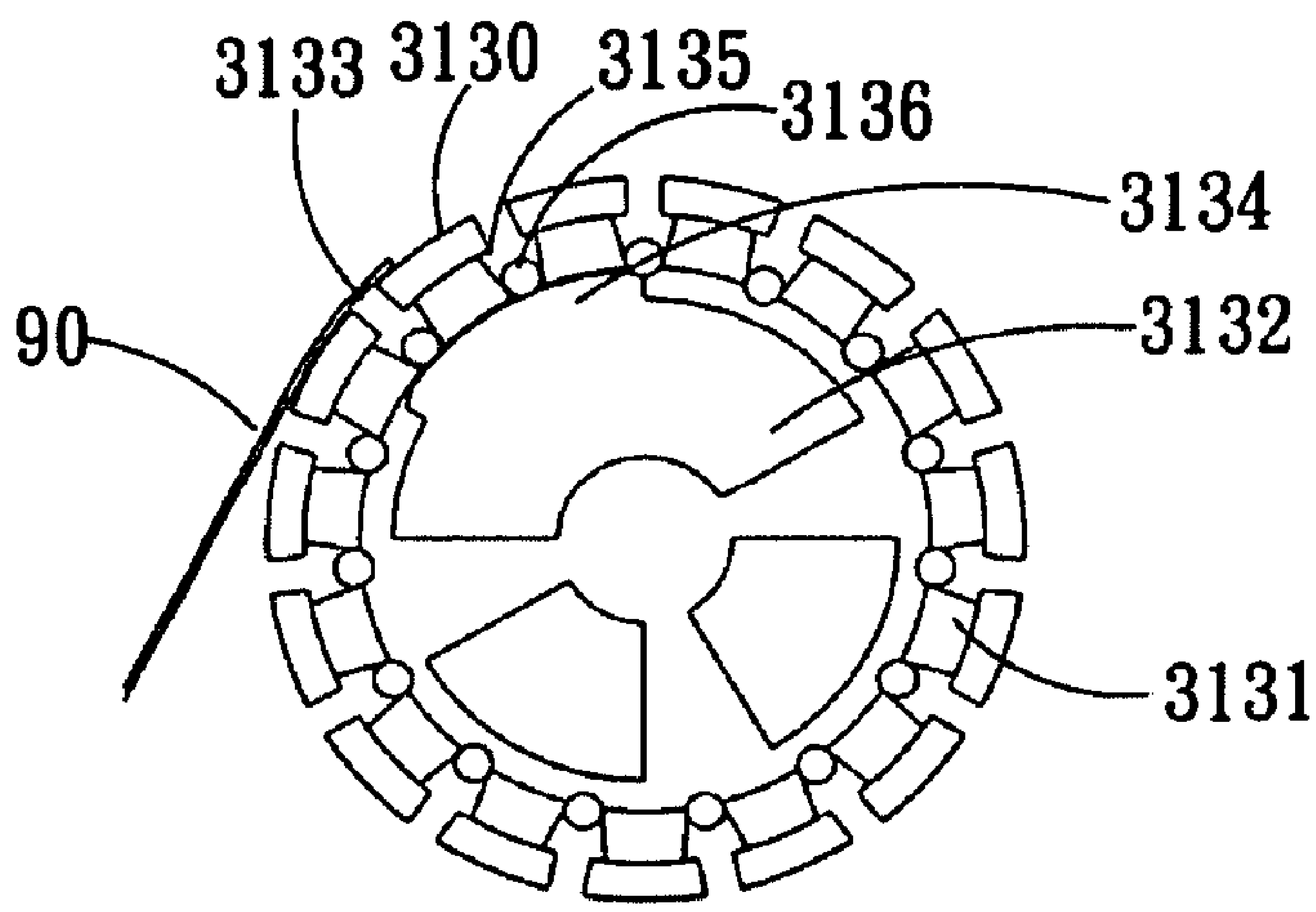


FIG. 14A

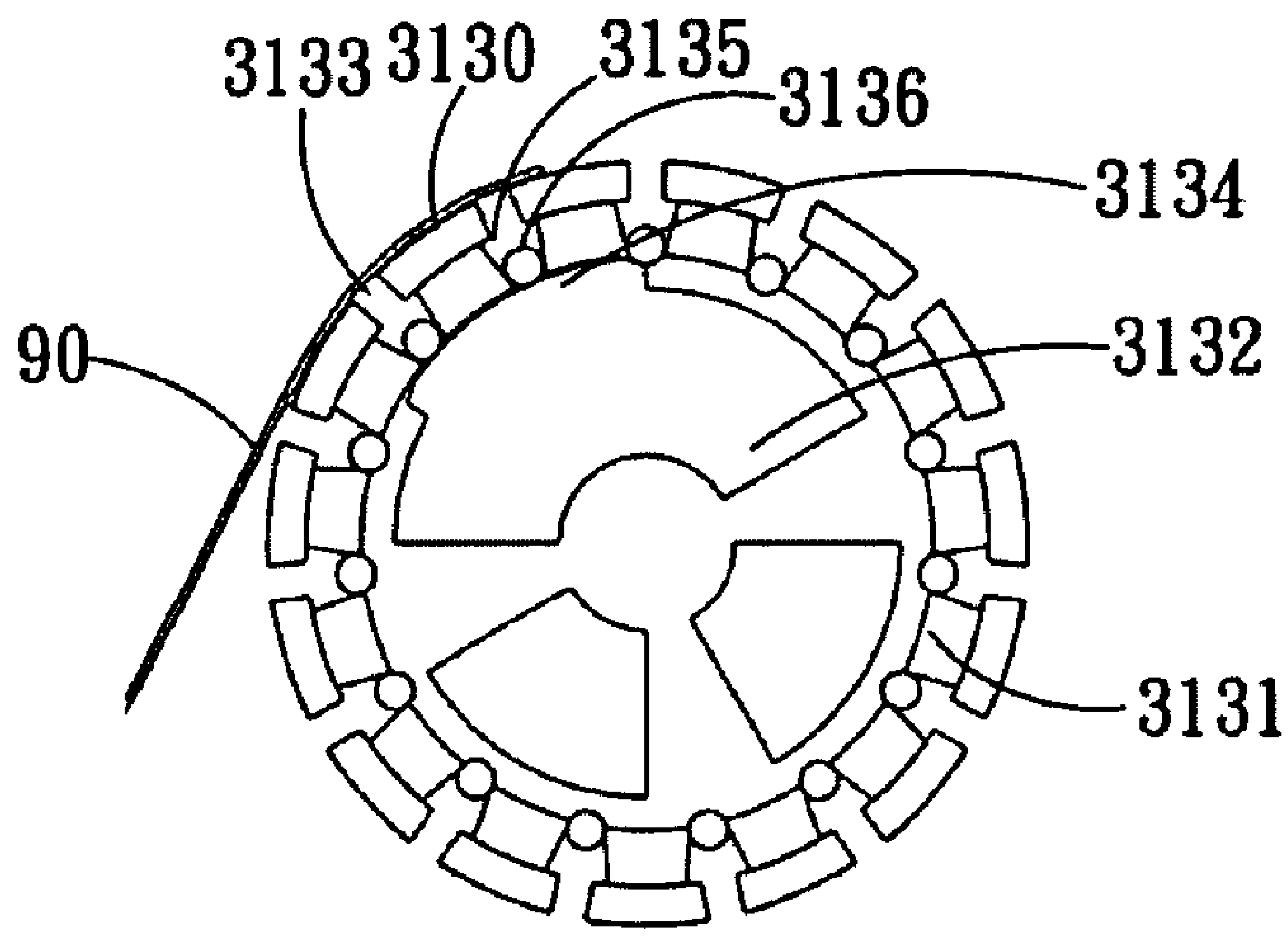


FIG. 14B

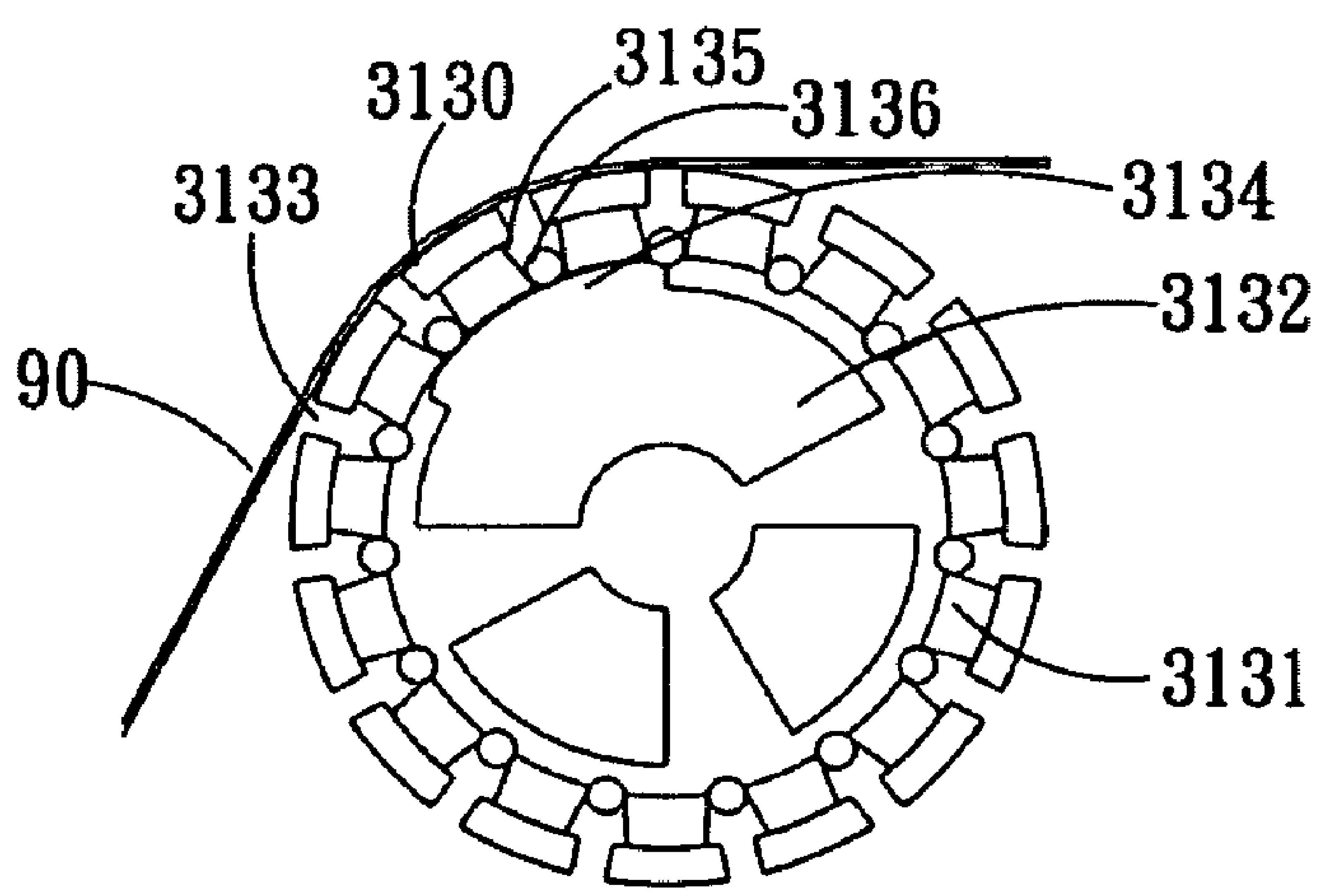


FIG. 14C

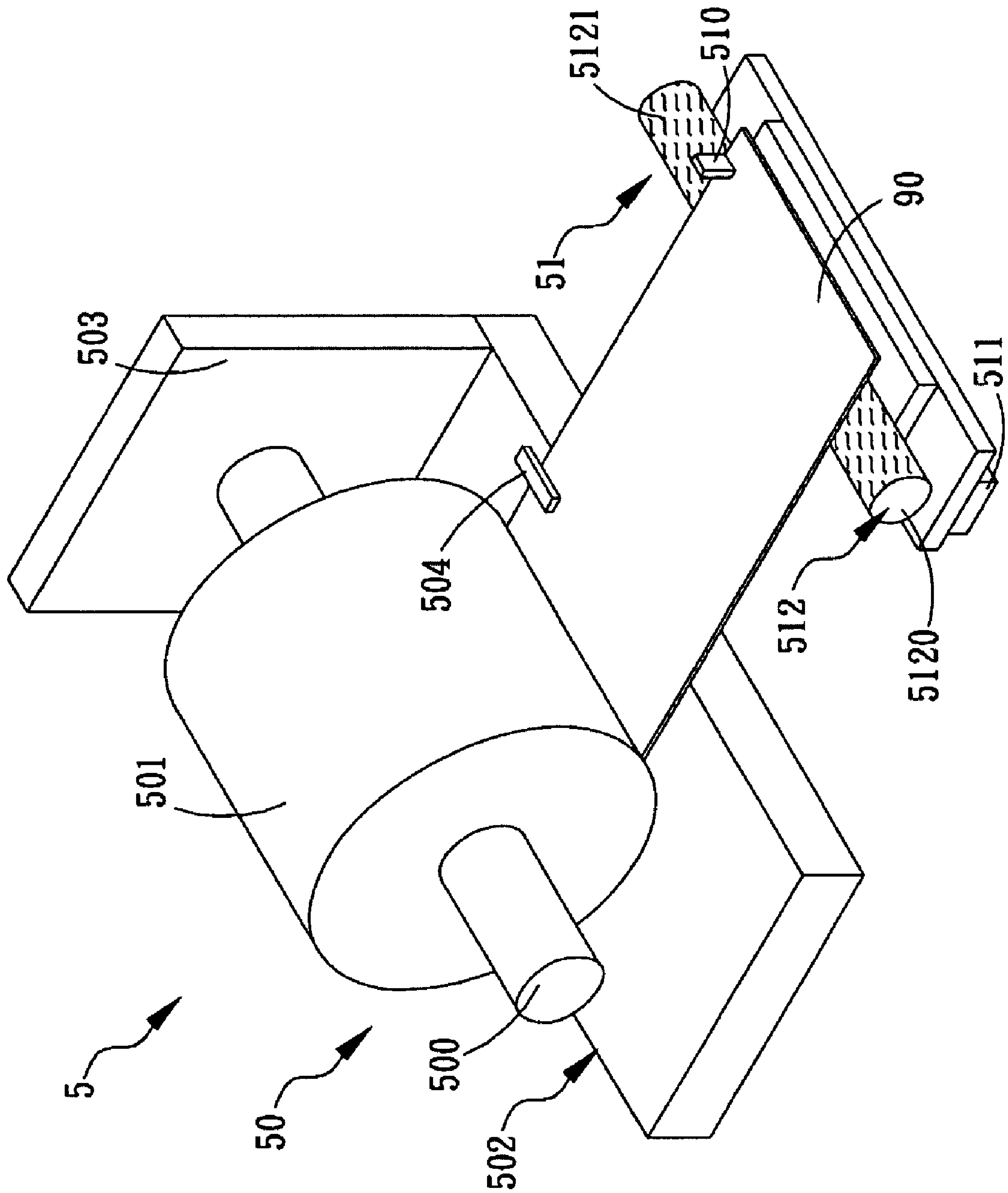


FIG. 15

WEB TRANSPORTATION GUIDING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to a position guiding technology, and more particularly to a web transportation guiding apparatus and method for guiding a position shift occurred during web transportation.

2. Related Art

FIG. **1** is a schematic view illustrating that a web has a shift. Since the web **90** has had a lateral shift δ during a winding, which causes a situation that the web **90** snakes when being unwound through a roller **10**. An edge of the web **90** continuously shifts from a position of c towards a position of d during the unwinding, such that a lateral shift on the edge after the web **90** is unwound is exactly δ. The above situation is merely one of the causes for the snaking of the web. Moreover, the inconsistent parallelism between the rollers in a roll to roll equipment is a common reason why the web snakes. Therefore, a good edge tracing guiding module is needed to effectively solve the problem of the snaking of the web.

A swing-type edge tracing guiding apparatus available on the market is generally used during the web transportation, however, some problems cannot be directly alleviated in usage. Not because the usage of the swing-type edge tracing guiding apparatus has disadvantages, but the principle of the swing-type edge tracing restricts the overall guiding precision and response speed in some special situations. FIG. **2** is a schematic view of the swing-type edge tracing guiding apparatus. In the swing-type guiding apparatus in the prior art, the web shift must be compensated by rotating a specific angle for the swing-type edge tracing guiding apparatus. Therefore, when a tiny shift is to be compensated, a driving apparatus must have a higher angle resolution to compensate the tiny shift precisely.

In addition, in FIG. **2**, for a sensor **11**, the web before a critical line A has a tendency of shifting to the right. Therefore, when the web before the critical line A reaches the sensor, an included angle θ**1** must be formed between the swing-type edge tracing guiding apparatus and the critical line A, so as to effectively maintain the edge position of the web at a reference O. However, it should be particularly noted that once the web after the critical line A reaches the sensor, since the web has a tendency of shifting to the left for the sensor, the swing-type edge tracing guiding apparatus must be driven immediately to form an included angle θ**2** with the critical line A, so as to effectively maintain the edge position of the web at the reference O. It should be noted that the swing-type edge tracing guiding apparatus must be rotated by an angle of θ**1**+θ**2** in an extremely short time, but the swing-type edge tracing guiding apparatus is hardly able to respond with a proper angle in time, such that the edge position of the web is deviated from the reference O.

FIG. **3** is a schematic view illustrating an error of a swing-type edge tracing guidance in the prior art. An edge position of a web **18** is measured by a sensor **24** that is generally placed between rollers **16** and **22**, and a transportation reference of the web **18** is set at a position at a distance X from a point C. The roller **16** may swing left and right, so as to compensate the shift during the transportation of the web **18**. As shown in FIG. **3**, when a shift occurs to the web **18** during the transportation, an included angle D is formed between the roller **16** and the roller **22** in order to compensate the shift, and thus a deflection is generated in a region **28** between the rollers **16** and **22**. Although the position of the web **18** detected by the sensor **24** has always been maintained at X, the position of the web **18** after leaving the roller **24** has been changed to Y due to a distance between the sensor **24** and the roller **22**. Therefore, a compensation error δ is generated, and δ=X−Y.

In another guiding manner, a translation-type guiding apparatus is used, but a situation in which a moving travel **12** of a linear moving platform reaches a travel limit (as shown in FIG. **4**A) may occur to the apparatus, such that the function of adjusting a shift of a web **90** is restricted. Moreover, a situation in which the web **90** shifts beyond a clamping range of a roller **13** (as shown in FIG. **4**B) may occur to the translation-type guiding apparatus. The two situations often occur during the usage of the translation-type guiding apparatus. When encountering the above situations in FIGS. **4**A and **4**B, those of ordinary skill in the art often wrongly believe that the problems lie in an insufficient roller length or motor travel, and that the problems can be alleviated as long as the roller length or motor travel is increased. However, this is always not the case. Even if the roller length or motor travel is increased, the time points at which the above situations occur are delayed, but these problems cannot be solved effectively.

Furthermore, U.S. Pat. No. 7,267,255 has disclosed a web trace adjustment apparatus in which a driving wheel capable of adjusting a shift is disposed in a gimbal direction, so as to adjust a trace along which a web intends to move. U.S. Pat. No. 6,705,220 has disclosed a web trace adjustment apparatus in which a pair of movable angle bars is used to guide a moving web to enter into or move out of a transportation system.

Additionally, U.S. Pat. No. 6,124,201 has also disclosed a web guiding manner, in which a side edge position of a web is monitored, and the position of the web is guided by an upstream guiding apparatus if a shift is found. In addition, U.S. Pat. No. 4,958,111 and U.S. Pat. No. 4,453,659 have also disclosed an apparatus for adjusting a web position.

SUMMARY OF THE INVENTION

The present invention is directed to a web transportation guiding apparatus, which detects a position of a side edge of a web to compensate and adjust the position of the side edge of the web in the web transportation in real time by a mechanism having a coarse adjustment and a fine adjustment if the position of the web is shifted.

The present invention is directed to a web transportation guiding method, which not only detects a position of a side edge of a web to compensate and adjust the position of the web in a transportation by a mechanism having a coarse adjustment and a fine adjustment, but also is capable of determining the fine adjustment mechanism about a moving limit, and controlling the coarse adjustment mechanism to change an edge tracing determination position reference thereof if the fine adjustment mechanism satisfies a condition for the moving limit.

The present invention is directed to a web transportation guiding apparatus and method that uses a coarse guiding module in combination with a fine guiding module. The fine guiding module is capable of meeting the demand for a high-precision edge tracing, and the coarse guiding module is capable of effectively solving the problem that the translation-type fine guiding module reaches a limit point, thereby realizing the web edge tracing technology with high-precision.

In an embodiment, the present invention provides a web transportation guiding apparatus, which includes a coarse position guiding module, a fine position guiding module, and a control module. The coarse position guiding module determines a position of a specific position on a web according to a reference sensor, so as to compensate a shift generated by the web during the web transportation. The fine position guiding module is disposed at one side of the coarse position guiding module, and compensates the shift generated by the web during the transportation according to the position of the specific position on the web. The control module determines whether to send a control signal to the coarse position guiding module according to a position of the fine position guiding module, so as to change the position reference.

In another embodiment, the present invention further provides a web transportation guiding method including the following steps. A coarse position guiding module and a fine position guiding module are provided, which are respectively provided for a web to pass through and may adjust a position of the web. The coarse position guiding module determines whether the position of the web is shifted according to a reference. If the fine position guiding module approaches a limit of the moving travel, the coarse position guiding module is notified to change the reference.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given herein below for illustration only, and thus are not limitative of the present invention, and wherein:

FIG. **1** is a schematic view illustrating that a web generates a shift;

FIG. **2** is a schematic view of a swing-type edge tracing guiding apparatus;

FIG. **3** is a schematic view illustrating an error of a swing-type edge tracing guidance in the prior art;

FIGS. **4**A and **4**B are schematic views illustrating a moving limit of a linear moving platform;

FIG. **5** is a schematic view of a web transportation guiding apparatus according to a first embodiment of the present invention;

FIG. **6** is a schematic flow chart of processes of a web transportation guiding method according to the present invention;

FIG. **7** is a schematic view illustrating a moving travel of an adjustment mechanism of a fine position guiding module in FIG. **5**;

FIG. **8** is a schematic view illustrating a parameter changed reference;

FIGS. **9**A and **9**B are top views illustrating an operation of the web transportation guiding apparatus according to the first embodiment of the present invention;

FIGS. **10**A and **10**B are schematic enlarged views of a coarse position sensor and a fine position sensor of the web transportation guiding apparatus according to the first embodiment of the present invention;

FIG. **11** is a schematic view of a web transportation guiding apparatus according to a second embodiment of the present invention;

FIG. **12**A is a schematic view of a web transportation guiding apparatus according to a third embodiment of the present invention;

FIG. **12**B is a schematic structural view of a suction roller of the present invention;

FIGS. **13**A to **13**D are schematic views of a valve of the present invention;

FIGS. **14**A to **14**C are schematic views illustrating that the suction roller of the present invention transports an object; and

FIG. **15** is a schematic view of a web transportation guiding apparatus according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In order to make the features, objectives, and functions of the present invention become more comprehensible, the structures and design ideas and reasons of relevant details of the apparatus in the present invention are illustrated below. The detailed illustration is stated as follows.

FIG. **5** is a schematic view of a first embodiment of a web transportation guiding apparatus of the present invention. Referring to FIG. **5**, in this embodiment, the web transportation guiding apparatus **3** includes a coarse position guiding module **30**, a fine position guiding module **31**, and a control module **32**. The apparatus **3** controls the coarse position guiding module **30** and the fine position guiding module **31** through the control module **32**. A web **90** is transported from the coarse position guiding module **30** towards the fine position guiding module **31**. Positions of specific positions on the web **90** can be individually detected through the coarse position guiding module **30** and the fine position guiding module **31** during the transportation of the web **90**, so as to be used as a basis for determining a compensation of the position of the web **90**, such that the web **90** is transported along preset positions. In this embodiment, the specific positions of the web **90** are, but not limited to, side edges **901** and **902**.

The coarse position guiding module **30** having an adjustment precision approximately in a range of hundreds of μm includes a coarse position sensor **300**, a coarse position control unit **301**, and an adjustment mechanism **302**. The coarse position sensor **300** is electrically connected to the coarse position control unit **301**, and the coarse position control unit **301** is electrically connected to the adjustment mechanism **302** and the control module **32**. The coarse position sensor **300** functions to measure a position of the side edge **901** of the web. The position value measured by the coarse position sensor **300** is returned to the coarse position control unit **301** to be analyzed. When determining that a shift occurs to the side edge **901** of the web **90**, the coarse position control unit **301** may control the adjustment mechanism **302** to compensate the shift of the web **90** in real time. The adjustment mechanism **302** may adjust the position of the side edge of the web **90** in a manner of a linear displacement motion or a swing motion. In this embodiment, the adjustment motion is the swing motion.

The adjustment mechanism **302** further has a pair of rollers **3020** and a linear moving platform **3021**. The pair of rollers **3020** has a pivot point **3022**. The linear moving platform **3021** is connected to the pair of rollers **3020**. The linear moving platform **3021** swings the pair of rollers **3020** about the pivot point **3022** according to the coarse position control signal, thereby driving the web **90** to swing left and right, so as to achieve the edge tracing guiding effect. In addition, a roller **33** is used to change a traveling height of the web **90**, such that the web **90** can pass by the pair of rollers **3020** during the transportation. The adjustment mechanism **302** belongs to the prior art and will not be repeated herein. Another kind of adjustment mechanism adjusts the position of the web in a manner of translational motion.

As shown in FIG. **5**, the fine position guiding module **31** having a control precision in a range of tens of μm includes an adjustment mechanism **310**, a fine position sensor **311**, and a fine position control unit **312**. A position value measured by the fine position sensor **311** is returned to the fine position control unit **312** to be analyzed. When determining that a shift occurs to the side edge **902** of the web **90**, the fine position control unit **312** may control the adjustment mechanism **310** to compensate the shift of the web **90** in real time. The fine position guiding module **31** may be regarded to have the fine positioning function. The fine position guiding module **31** employs a lateral translation-type edge tracing manner, and the adjustment mechanism **310** thereof may perform the translation-type edge tracing guidance on the web in a clamping, adsorption, or friction manner. In this embodiment, the adjustment mechanism **310** is a translation-type clamping mechanism which may perform a linear displacement movement to adjust the position of the web **90**. In this embodiment, the adjustment mechanism **310** has a pair of rollers **3100** and a linear moving platform **3101**. The pair of rollers **3100** may be provided for clamping the web **90**. The linear moving platform **3101** is coupled to the pair of rollers **3100**, and drives the pair of rollers **3100** to generate a linear displacement motion according to the fine position control signal, thereby adjusting the position of the web.

In addition, the adjustment mechanism **310** further has an encoder **3102** electrically connected to the control module **32**. The encoder **3102** may return an absolute position of the linear moving platform **3101** of the adjustment mechanism **310** to the control module **32**, such that the control module **32** gets to know a position status of the adjustment mechanism **310** at any time. The type and principle of the encoder **3102** belong to the prior art and will not be repeated herein. When the control module **32** confirms that the position about the adjustment mechanism **310** returned by the encoder **3102** is about to reach a limit point of a certain edge according to the position, the control module **32** transfers a control instruction to the coarse position control unit **301**, and the coarse position control unit **301** changes an edge tracing reference position of the coarse position guiding module **30** according to the content of the control instruction. In addition, although the above control module **32**, coarse position control unit **301**, and fine position control unit **312** are separated from each other in the implementation, they can be integrated by those skilled in the art to similarly achieve the specific effect of the present invention. The control module **32** may be, but not limited to, various processors such as a computer, a control chip IC, or a programmable logic controller (PLC).

Referring to FIGS. **5** and **6**, FIG. **6** is a schematic flow chart of processes of a web transportation guiding method according to the present invention. In this embodiment, the guiding method **4** includes control rules of the coarse position guiding module **30** and the fine position guiding module **31**. A block B is the control rule of the coarse position guiding module **30**, and a block A is the control rule of the fine position guiding module **31**. In Step **40**, the control rules of the coarse position guiding module **30** and the fine position guiding module **31** may be activated simultaneously, or the control rule of the coarse position guiding module **30** or the control rule of the fine position guiding module **31** may be activated alone. In Step **400**, it is first determined whether the fine position guiding module **31** approaches a moving limit of the adjustment structure. FIG. **7** is a schematic view illustrating a moving travel of the adjustment mechanism of the fine position guiding module **31** in FIG. **5**. In FIG. **7**, D represents a linear movement range of the linear moving platform **3101** of the entire adjustment mechanism. In order to prevent the adjustment mechanism from moving to limits, i.e., two ends of D when compensating the web position, the present invention defines a movement interval d as a reference of safe movement, that is, uses regional ranges between boundaries of the movement interval d and boundaries of the linear movement range D as a basis for determining whether the fine position guiding module approaches the limit of the moving travel. The size of the regional ranges between the boundaries of the movement interval d and the boundaries of the linear movement range D may depend on demands and is not limited. Referring to FIGS. **5** and **6** again, in Step **400**, it is determined whether the adjustment mechanism **310** moves beyond the range of the movement interval d. If a position of the linear moving platform **3101** of the fine position guiding module **31** is still a distance from the limit point, the flow proceeds to Step **401** in which the fine position sensor **311** is used to measure a position of the side edge **902** of the web **90**. In Step **402**, it is determined whether a shift occurs to the web **90**. If a shift occurs, the flow proceeds to Step **403** in which the fine position guiding module **31** is driven to compensate the shift of the web **90**. Then, the flow returns to Step **400** through Step **412**, and is executed repeatedly.

After a series of repeated executions of Steps **400-403**, if in Step **400** it is first determined that the fine position guiding module **31** has approached the travel limit point, i.e., exceeded the range of the movement interval d U.S. Pat. No. 4,958,111 and U.S. Pat. No. 4,453,659 in FIG. **7**, the flow proceeds to Step **404** of sending out a signal to change an edge tracing reference of the coarse position guiding module **30**, and to Step **405** of sending out an abnormal warning. The block B is the control rule of the coarse position guiding module, in which a coarse edge tracing work on the web may be performed independently. First, in Step **407**, it is detected whether a trigger signal from Step **404** exists. Once the signal of Step **404** is received in Step **407**, the flow proceeds to Step **411** to change the edge tracing reference of the coarse position guiding module **30**. The edge tracing reference of the coarse position guiding module may be changed by moving the position of the coarse position sensor **300** or by setting a parameter, but not limited thereto. FIG. **8** is a schematic view illustrating a parameter changed reference. Before the reference is changed by the use of a parameter, it is determined that a reference position **91** of a side edge shift of the web is at a center of the coarse position sensor **300**, i.e., a zero point. However, if the reference for determination is to be changed by the use of the parameter, the change may be made in a software manner to move the position of the zero point to the left or to the right since the position of the coarse position sensor **300** is not changed. In FIG. **8**, the position of the zero point is moved to the left to the position of a label **92**. That is, if the reference is changed to the position **92**, the side edge of the web **90** is determined as shifted if not at the position of **92**.

Referring to FIGS. **5** and **6** again, the flow immediately proceeds to Step **408** to measure the edge position of the web. Then, in Step **409**, it is determined whether a shift occurs to the web according to a new edge tracing reference changed in Step **411**. Afterwards, the coarse position guiding module **30** is driven to compensate the shift of the web **90** in Step **410**. After that, the flow returns to Step **407** again to perform an edge tracing guidance. The above illustrates the flow of the edge tracing guidance performed in the block B after the signal of Step **404** is received. When the edge tracing reference of the coarse position guiding module needs not to be changed in a normal situation, the flow directly proceeds from Step **407** to Step **408** to measure the side edge position of the web **90**. Afterwards, in Step **409**, it is determined whether a shift occurs to the web **90** according to an edge tracing reference that is set finally. Then, the coarse position guiding module **30** is driven to compensate the shift of the web **90** in Step **410**. In Step **412**, it is determined whether to stop the edge tracing on the web **90**. If the user requires stopping the edge tracing operation on the web **90**, the flow of the web transportation guiding method **4** is ended. The specific efficacy of the present invention for preventing from moving to the limit can be realized by Step **411** in the web transportation guiding method **4**, because the problem that the fine position guiding module reaches the limit point can be solved by changing the edge tracing reference of the coarse position guiding module. In addition, the steps other than Step **411** in the flow of the web transportation guiding method can be deleted or changed randomly in sequence upon demands.

Although the pure usage of a translation-type guiding module for performing the edge tracing guidance on the web can obtain a higher edge tracing precision than the usage of a swing-type guiding module alone, after the translation-type guiding module is used alone for a period of time, a limit point of a certain edge may be reached and the edge tracing cannot be continued, and a time point at which the situation occurs cannot be predicted. This is usually associated with an edge roughness when the web is unwound or a parallelism of rollers of the equipment. Especially when the parallelism of the rollers is undesirable, the web always tends to shift in a fixed direction, and the translation-type guiding module soon reaches a limit point of a certain edge under the effect of a recovery of the web in order to compensate the shift of the web.

FIGS. **9**A and **9**B are top views illustrating an operation of the web transportation guiding apparatus according to the first embodiment of the present invention. Whether the linear moving platform exceeds limit points R (a right limit) and L (a left limit) of the movement interval d can be effectively grasped through the encoder **3102**. Taking FIG. **9** as an example, since the linear moving platform **3101** is connected to the roller **3100** by a platform **3103**, the platform **3103** is driven by the linear moving platform **3101** to move on a track of the linear moving platform **3101**, thereby driving the roller **3100** to move. When the platform **3103** is moved to reach the travel limit point L of the linear moving platform **3101**, it indicates that the coarse position guiding module **30** always transports the web **90** in a certain direction. Therefore, after the web **90** enters into the fine position guiding module **31**, the fine position guiding module **31** must continuously guide the web **90** in the same direction, such that finally the platform **3103** gradually approaches the travel limit point L. Currently, the common equipment cannot effectively ensure that the web remains perpendicular to the rollers during the actual web transportation. Therefore, when the web **90** enters into the coarse position guiding module **30**, an angle difference θ exists between the web **90** and the roller **33**, and the sensor **300** of the coarse position guiding module **30** may measure a position of the edge of the web **90**. Once a shift generated by the edge of the web **90** is found, the roller **3020** is driven to swing by the linear moving platform **3021** to compensate the shift, such that the edge of the web **90** can be effectively maintained at a position of an edge tracing reference m of the coarse position guiding module **30**. After the web **90** passes through the coarse position guiding module **30**, a coarse positioning of the web **90** can be regarded as completed. The web **90** subsequently enters into the fine position guiding module **31**. The fine position guiding module **31** used in the first embodiment employs the translation-type edge tracing manner. In this manner, the sensor **311** of the fine position guiding module **31** may measure a position of the web edge. Once a shift generated by the web edge is found, the roller **3100** is driven to translate by the linear moving platform **3101** to compensate the shift, such that the web edge can be effectively maintained at a position of an edge tracing reference n of the fine position guiding module **31**.

It can be found from FIG. **9**A that an error ΔX exists between the edge tracing reference n of the fine position guiding module **31** and the edge tracing reference m of the coarse position guiding module **30**, because human errors or errors in mechanism assembly are difficult to avoid when the sensors **300** and **311** are erected. Therefore, no error exists between the edge tracing references n and m cannot be effectively determined, and because of the existence of the error ΔX, the fine position guiding module **31** reaches the limit of a certain edge after operating for a period of time. In FIG. **9**A, for example, an edge of the platform **3103** of the linear moving platform **3101** reaches the left limit L, and the linear moving platform **3101** has an insufficient travel to continue performing the edge tracing guidance to the left. Since the coarse position guiding module **30** controls the web edge at the position of the edge tracing reference m but the fine position guiding module **31** needs to control the web edge at the position of the edge tracing reference n, the linear moving platform **3101** should drive the roller **3100** to translate so as to compensate the shift ΔX, such that the position of the web edge is compensated from m to n. Since the fine position guiding module **31** must compensate the shift ΔX continually, and meanwhile the web **90** is subjected to a recovery force and generates a recovery, finally the edge of the platform **3103** of the linear moving platform **3101** is moved to the left limit L under repeated actions of the compensation of the shift ΔX and the recovery.

Therefore, in an algorithm of the present invention, when the linear moving platform **3101** reaches or approaches the left limit L, a signal is sent to the coarse position guiding module **30** to require changing the edge tracing reference m of the coarse position guiding module **30**, such that the linear moving platform **3101** of the fine position guiding module **31** may have sufficient travel to continue compensating the shift. When the edge of the platform **3103** of the linear moving platform **3101** reaches or approaches the position of the left limit L, the algorithm of the present invention sends out the signal to the coarse position guiding module **30** and changes the edge tracing reference m of the coarse position guiding module **30**. The edge tracing reference m of the coarse position guiding module **30** is modified intentionally with the wish that the linear moving platform can be moved in a direction away from the limit point L so as to return to the center of the travel by changing the position where the web **90** enters into the fine position guiding module **31**. In addition, when the platform **3103** of the linear moving platform **3101** reaches or approaches the position of the right limit R, the algorithm similarly sends out a signal to the coarse position guiding module **30** and changes the reference.

How the novel solution solves the problem that the translation-type guiding module reaches the limit point by changing the edge tracing reference position of the swing-type guiding module will be illustrated below. As shown in FIG. **9**B, with the procedure in FIG. **6**, when it is found that the limit L is to be exceeded, a signal is sent out to the coarse position guiding module **30** to require changing the edge tracing reference m of the coarse position guiding module **30**. At this time, the edge tracing reference of the coarse position guiding module **30** is changed from m to m'. FIG. **10**A is a partial enlarged view of the edge tracing reference of the coarse position guiding module **30**, as shown in the figure, it can be found that the edge tracing reference m' after the change is spaced at a distance of ΔP from the edge tracing reference m before the change. The distance of ΔP may be achieved by moving the position of the sensor or changing internal settings of the algorithm as described above, and will not be repeated herein. FIG. **10**B is a partial enlarged view of the edge tracing reference of the fine position guiding module **31**, as shown in the figure, originally an error ΔX exists between the edge tracing reference m of the coarse position guiding module **30** and the edge tracing reference n of the fine position guiding module **31**, the edge tracing reference of the coarse position guiding module **30** is changed from m to m' because of a variation of the distance ΔP generated by the change of the edge tracing reference, and ΔP≧ΔX. Therefore, a new error ΔD is generated between the edge tracing reference m' of the coarse position guiding module **30** and the edge tracing reference n of the fine position guiding module **31**. Because of the new error ΔD between the edge tracing references of the coarse position guiding module **30** and the fine position guiding module **31**, the problem that the edge of the platform **3103** of the linear moving platform **3101** shifts towards the left limit L can be solved exactly through the error ΔD. Since the fine position guiding module **31** finds that the coarse position guiding module **30** controls the web edge at the position of the edge tracing reference m' but the fine position guiding module **31** needs to control the web edge at the position of the edge tracing reference n, the linear moving platform **3101** should drive the roller **3100** to translate so as to compensate the shift ΔD, such that the position of the web edge is compensated from m' to n. Since the fine position guiding module **31** must compensate the shift ΔD continually, and meanwhile the web **90** is subjected to a recovery force and generates a recovery, finally the edge of the platform **3103** of the linear moving platform **3101** is away from the left limit L under repeated actions of the compensation of the shift ΔD and the recovery, and the problem that the translation-type guiding module reaches the limit point is effectively solved.

FIG. **11** is a schematic view of the web transportation guiding apparatus according to a second embodiment of the present invention. This embodiment is basically the same as the embodiment in FIG. **5**. The difference lies in that the roller **3100** in the upper side of the adjustment structure **310** of the fine position guiding module **31** has a recess **3104**. Since a circuit or pattern may be formed on the web surface due to a process, and the upper roller tends to crush the process pattern or circuit on the web surface in the manner of FIG. **5**, a replacement with the roller **3100** having the recess **3104** may avoid the damage to the web surface. The implementation and control method of the embodiment in FIG. **11** is as described above and will not be repeated herein.

FIG. **12**A is a schematic view of the web transportation guiding apparatus according to a third embodiment of the present invention. This embodiment is basically the same as that in FIG. **5**. The difference lies in that the fine position guiding module uses a suction roller **313** to replace the roller set clamping the web **90** with a vacuum adsorption manner, and controls the position of the web **90** by adjusting a left and right position of the suction roller **313**. This is because the left and right deviation position of the web **90** can be adjusted upon an adsorption of the web **90** by the suction roller **313**, and the web **90** keeps its position never changed under a suction force. FIG. **12**B is a schematic structural view of the suction roller according to the present invention. In this embodiment, the suction roller **313** has an outer sleeve **3130**, an outer roller **3131**, and an inner roller **3132**. The outer sleeve **3130** has a plurality of first through holes **3133**. A material of the outer sleeve **3130** is one selected from among steel, glass, ceramic, fiber, and plastic materials. The outer roller **3131** is accommodated in the outer sleeve **3130** and has a plurality of second through holes **3135** corresponding to the plurality of first through holes **3133**. Each of the second through holes **3135** is provided for accommodating a valve **3136**. In this embodiment, the second through hole **3135** is a conical hole. In order to prevent the valve **3136** from dropping off the first through hole **3133** when the outer roller **3131** is rotated to a specific position, an aperture of the first through hole **3133** is smaller than the outermost aperture of the second through hole **3135**. FIGS. **13**A to **13**D are schematic views of the valve according to the present invention. In order to match with the second through hole **3135**, the valve **3136** may be a sphere shown in FIG. **13**A or a cone shown in FIG. **13**B. Furthermore, the valve **3136** may also be long strip shaped, for example, a circular cylinder in FIG. **13**C or a cone cylinder in FIG. **13**D. It is understood that if the valve **3136** is cylindrical shaped, the second through hole **3135** is also an elongated hole matching therewith. A material of the valve **3136** is one selected from among steel, glass, ceramic, fiber, and plastic materials. The suction roller **313** may be connected to a negative pressure source **3138** through pipe lines **3137** at one side thereof. The negative pressure source **3138** provides a negative pressure, such that the suction roller **313** generates a suction force to adsorb the web **90**.

FIGS. **14**A to **14**C are schematic views illustrating that the suction roller of the present invention transports an object. In FIG. **14**A, the web **90** is adsorbed upon contacting the surface of the outer sleeve **3130**. Because the valve **3136** contacting a convex portion **3134** of the inner roller **3132** is pressed open by the inner roller **3132** so as not to completely close the second through hole **3135**, the negative pressure may adsorb the web **90** through the first through hole **3133**. As shown in FIG. **14**B, when the outer sleeve **3130** is rotated, the valve **3136** is rotated accordingly. During the rotation of the outer sleeve **3130**, the valve **3136** is pressed against the convex portion **3134** on the inner roller **3132** in turn with the rotation, so as to form a vacuum air flow gap instead of originally plugging the second through hole **3135** of the outer roller **3131** to generate a vacuum adsorption to directly adsorb the web **90** and transport the web **90**. When a position of the suction roller **313** is adjusted left and right, the web **90** is pulled to move left and right and keeps its position never changed under a suction force. As shown in FIG. **14**C, after departing from the convex portion **3134**, the rotated valve **3136** is sucked again by the negative pressure passing through the second through hole **3135** to plug the second through hole **3135**, so as to close the vacuum air flow gap. At this time, the web **90** is released without the vacuum air flow adsorption. Through the rotation of the suction roller **313**, the valves **3136** above the convex portion **3134** tightly adsorb the web **90** by the vacuum air, and the valves **3136** in regions (the regions that the convex portion **3134** is not pressed against) where the web **90** is not adsorbed plug the second through holes **3135** of the outer roller **3131**, so as to transport the web **90** forward gradually.

FIG. **15** is a schematic view of the web transportation guiding apparatus according to a fourth embodiment of the present invention. In this embodiment, the web transportation guiding apparatus **5** includes a coarse position guiding module **50** and a fine position guiding module **51**. The fine position guiding module **51** employs a lateral translation-type edge tracing manner to perform a translation-type edge tracing guidance on the web **90** in a friction manner. The fine position guiding module **51** has a fine position sensor **510**, a fine position control module **511**, and an adjustment mechanism **512**. Functions and structures of the fine position sensor **510** and the fine position control module **511** are the same as those described above and will not be repeated herein. The adjustment mechanism **512** has a friction roller **5120** having a rough surface structure **5121** through which the friction roller **5120** have friction with the web **90**. A position of a side edge of the web **90** is measured by the fine position sensor **510**. Once a shift generated by the side edge of the web **90** is found, a linear moving platform **5122** connected to the friction roller **5120** moves the friction roller **5120**. At this time, the friction roller **5120** may have friction with the web **90** and drive the web **90** to move, so as to guide the shift of the web. A structure of the linear moving platform **5122** is as described above and will not be repeated herein.

Furthermore, in this embodiment, the coarse position guiding module **50** is a lateral translation-type edge tracing guiding apparatus and has a rotatable roller **500**. Since it is rotatable, the roller **500** can be used to carry a web roll **501** to unwind the web. In addition, the roller **500** may also wind up the web at the end of the process to form the web roll **501** in FIG. **15**. The roller **500** and a linear moving platform **502** of the coarse position guiding apparatus **50** are connected to each other via a block vertical plate **503**. The detailed connection manner belongs to the prior art and will not be repeated herein. A shift of the side edge of the web **90** is measured by a coarse sensor **504**. The linear moving platform **502** is operated in a lateral translation manner, and thus drives the web **90** to translate left and right so as to achieve the edge tracing guiding effect. The interaction between the coarse position guiding apparatus **50** and the fine position guiding apparatus **51** may be as described according to the flow in FIG. **6** and will not be repeated herein.

The above descriptions are merely preferred embodiments of the present invention, but not intend to limit the scope of the present invention. It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

To sum up, the web transportation guiding apparatus and method provided in the present invention uses the coarse guiding module in combination with the fine guiding module. The fine guiding module is capable of meeting the demand for a high-precision edge tracing, and the coarse guiding module is capable of effectively solving the problem that the translation-type fine guiding module reaches a limit point, thereby realizing the web edge tracing technology with high-precision. Therefore, the present application has been able to raise the industrial competitiveness and spur the development of peripheral industries and met the requirements for an invention application according to the provisions of the Invention Patent Law. Thus, we file the present application for a patent according to the law and would be appreciated if the Examiner examines it and grants it a patent.

What is claimed is:

1. A web transportation guiding apparatus, comprising:

a coarse position guiding module having an adjustment precision approximately in a range of hundreds of micrometers, for determining a position of a specific position on a web according to a reference, so as to compensate a shift generated by the web during a transportation;

a fine position guiding module having a control precision in a range of tens of micrometers and disposed at one side of the coarse position guiding module, for compensating the shift generated by the web during the transportation according to the position of the specific position on the web; and

a control module, for determining whether to send a control instruction to the coarse position guiding module according to a position of the fine position guiding module, so as to change the reference.

2. The web transportation guiding apparatus according to claim **1**, wherein the specific position is a side edge or a reference mark on a surface of the web.

3. The web transportation guiding apparatus according to claim **1**, wherein the coarse position guiding module further comprises:

a coarse position sensor, for sensing the position of the specific position on the web to generate a coarse position sensing signal;

a coarse position control module, electrically connected to the coarse position sensor, for generating a coarse position control signal according to the coarse position sensing signal; and

an adjustment mechanism, electrically connected to the coarse position control module, for generating an adjustment motion according to the coarse position control signal so as to adjust the position of the web.

4. The web transportation guiding apparatus according to claim **3**, wherein the adjustment mechanism further comprises:

a pair of rollers, having a pivot point; and

a linear moving platform, connected to the pair of rollers, for generating a linear displacement motion according to the coarse position control signal so as to rotate the pair of rollers about the pivot point.

5. The web transportation guiding apparatus according to claim **3**, wherein the adjustment mechanism further comprises:

at least a roller, for supporting the web; and

a linear moving platform, coupled to the at least one roller, for generating a linear displacement motion according to the coarse position control signal to make the at least one roller move.

6. The web transportation guiding apparatus according to claim **3**, wherein the fine position guiding module further comprises:

a fine position sensor, for sensing the position of the specific position on the web to generate a fine position sensing signal;

a fine position control module, electrically connected to the fine position sensor, for generating a fine position control signal according to the fine position sensing signal; and

an adjustment mechanism, electrically connected to the fine position control module, for generating an adjustment motion according to the fine position control signal so as to adjust the position of the web.

7. The web transportation guiding apparatus according to claim **6**, wherein the adjustment mechanism further comprises:

a pair of rollers, for clamping the web; and

a linear moving platform, coupled to the pair of rollers, for driving the relevant rollers to generate a linear displacement motion according to the fine position control signal.

8. The web transportation guiding apparatus according to claim **7**, wherein the roller above the web further has a recess.

9. The web transportation guiding apparatus according to claim **6**, wherein the adjustment mechanism further comprises:

a suction roller, disposed at a bottom of the web, for adsorbing the web by a negative pressure; and

a linear moving platform, coupled to the suction roller, for driving the suction roller to generate a linear displacement motion according to the fine position control signal.

10. The web transportation guiding apparatus according to claim 9, wherein the suction roller further comprises:

an outer sleeve, having a plurality of first through holes;

an outer roller, accommodated in the outer sleeve, and having a plurality of second through holes corresponding to the plurality of first through holes, wherein each of the second through holes is provided for accommodating a valve; and

an inner roller, accommodated in the outer roller, and having a convex portion and a plurality of slots, wherein the convex portion leans against an inner wall of the outer roller.

11. The web transportation guiding apparatus according to claim 6, wherein the adjustment mechanism further comprises:

a friction roller, disposed at a bottom of the web, and having patterns on a surface thereof so as to lean against the web; and

a linear moving platform, coupled to the friction roller, for driving the friction roller to generate a linear displacement motion according to the fine position control signal.

12. The web transportation guiding apparatus according to claim 6, wherein the control module, the coarse position control module, and the fine position control module are integrated into one module.

13. The web transportation guiding apparatus according to claim 1, wherein the fine position guiding module further comprises:

a fine position sensor, for sensing the position of the specific position on the web to generate a fine position sensing signal;

a fine position control module, electrically connected to the fine position sensor, for generating a fine position control signal according to the fine position sensing signal; and

an adjustment mechanism, electrically connected to the fine position control module, for generating an adjustment motion according to the fine position control signal so as to adjust the position of the web.

14. The web transportation guiding apparatus according to claim 13, wherein the adjustment mechanism further comprises:

a pair of rollers, for clamping the web; and

a linear moving platform, coupled to the pair of rollers, for driving the pair of rollers to generate a linear displacement motion according to the fine position control signal.

15. The web transportation guiding apparatus according to claim 13, wherein the roller above the web further has a recess.

16. The web transportation guiding apparatus according to claim 13, wherein the adjustment mechanism further comprises:

a suction roller, disposed at a bottom of the web, for adsorbing the web by a negative pressure; and

a linear moving platform, coupled to the suction roller, for driving the suction roller to generate a linear displacement motion according to the fine position control signal.

17. The web transportation guiding apparatus according to claim 16, wherein the suction roller further comprises:

an outer sleeve, having a plurality of first through holes;

an outer roller, accommodated in the outer sleeve, and having a plurality of second through holes corresponding to the plurality of first through holes, wherein each of the second through holes is provided for accommodating a valve; and

an inner roller, accommodated in the outer roller, and having a convex portion and a plurality of slots, wherein the convex portion leans against an inner wall of the outer roller.

18. The web transportation guiding apparatus according to claim 13, wherein the adjustment mechanism further comprises:

a friction roller, disposed at a bottom of the web, and having patterns on a surface thereof so as to lean against the web; and

a linear moving platform, coupled to the friction roller, for driving the friction roller to generate a linear displacement motion according to the fine position control signal.

19. A web transportation guiding method, comprising:

providing a coarse position guiding module having an adjustment precision approximately in a range of hundreds of micrometers and a fine position guiding module having a control precision in a range of tens of micrometers, respectively, for a web to pass through and adjusting a position of the web, wherein the coarse position guiding module determines whether the position of the web is shifted according to a reference; and

notifying the coarse position guiding module to change the reference if the fine position guiding module approaches a limit of a moving travel.

20. The web transportation guiding method according to claim 19, wherein the process of the fine position guiding module adjusting the position of the web further comprises:

detecting a position of a side edge of the web; and

controlling the fine position guiding module to compensate a shift of the web if the position of the side edge is shifted.

21. The web transportation guiding method according to claim 20, wherein the fine position guiding module compensates the shift of the web by a translational motion.

22. The web transportation guiding method according to claim 19, wherein the process of the coarse position guiding module adjusting the position of the web further comprises:

detecting a position of a side edge of the web; and

controlling the coarse position guiding module to adjust the position of the web if the position of the side edge is shifted.

23. The web transportation guiding method according to claim 22, wherein the coarse position guiding module compensates the shift of the web by a translational motion.

24. The web transportation guiding method according to claim 22, wherein the coarse position guiding module compensates the shift of the web by a rotational motion.

25. The web transportation guiding method according to claim 19, further comprising sending out an abnormal warning if the fine position guiding module approaches the travel limit.

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